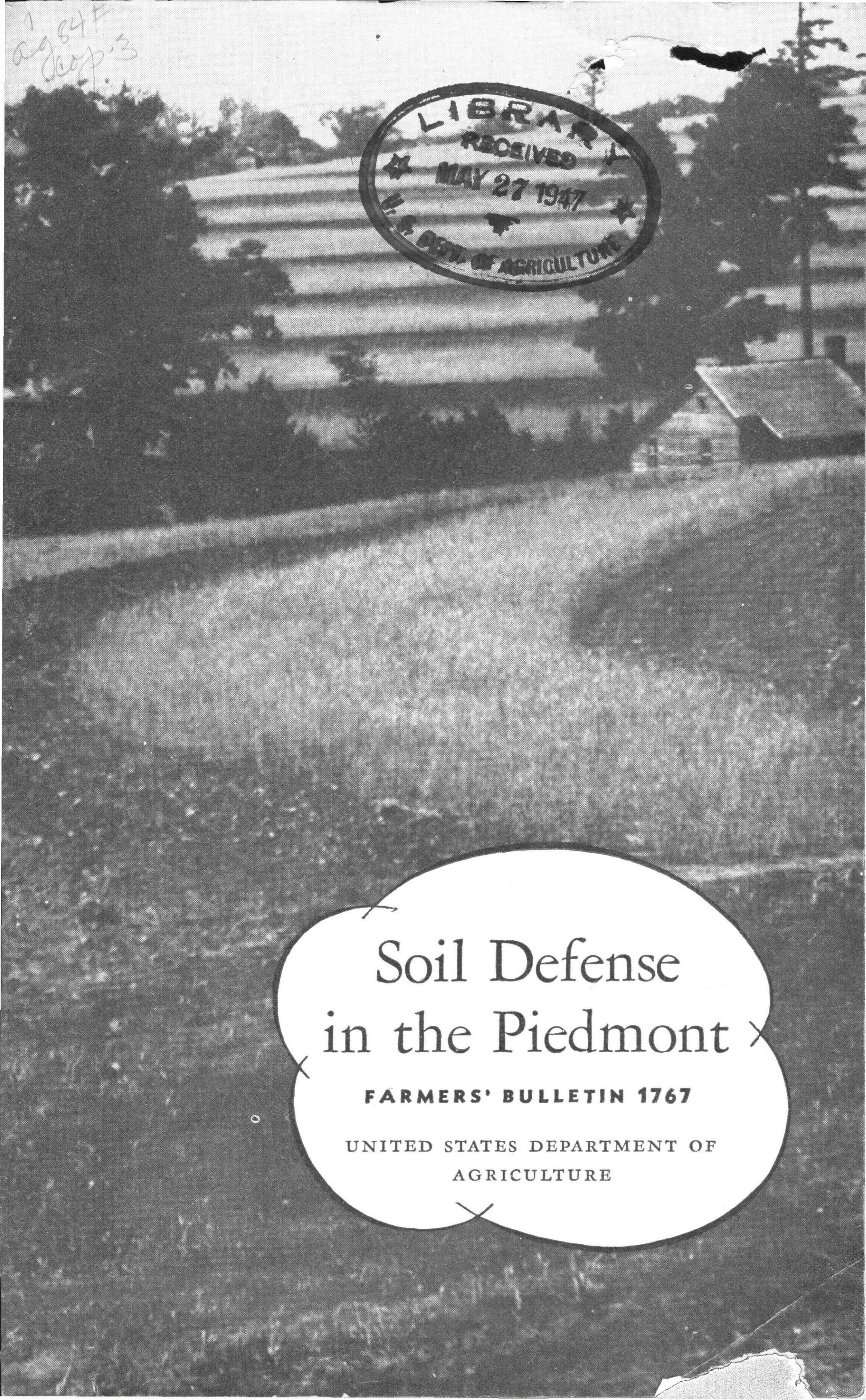

Soil Defense in the Piedmont

FARMERS' BULLETIN 1767

UNITED STATES DEPARTMENT OF AGRICULTURE

FOREWORD

This bulletin deals with erosion of the soil and measures of defense which have proved successful in controlling erosion in that part of the Piedmont country lying in the five States of Virginia, the Carolinas, Georgia, and Alabama. The region is the rolling foothill country of the Appalachian Range, and extends east and south to the fall line which separates the Piedmont from the broad, gently sloping Atlantic and Gulf Coastal Plains.

WASHINGTON, D. C., ISSUED JANUARY 1937.
REVISED JULY 1938.

Soil Defense in the Piedmont

By E. M. Rowalt, *in Collaboration with Subject-Matter Specialists of the Soil Conservation Service*

CONTENTS

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UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1938

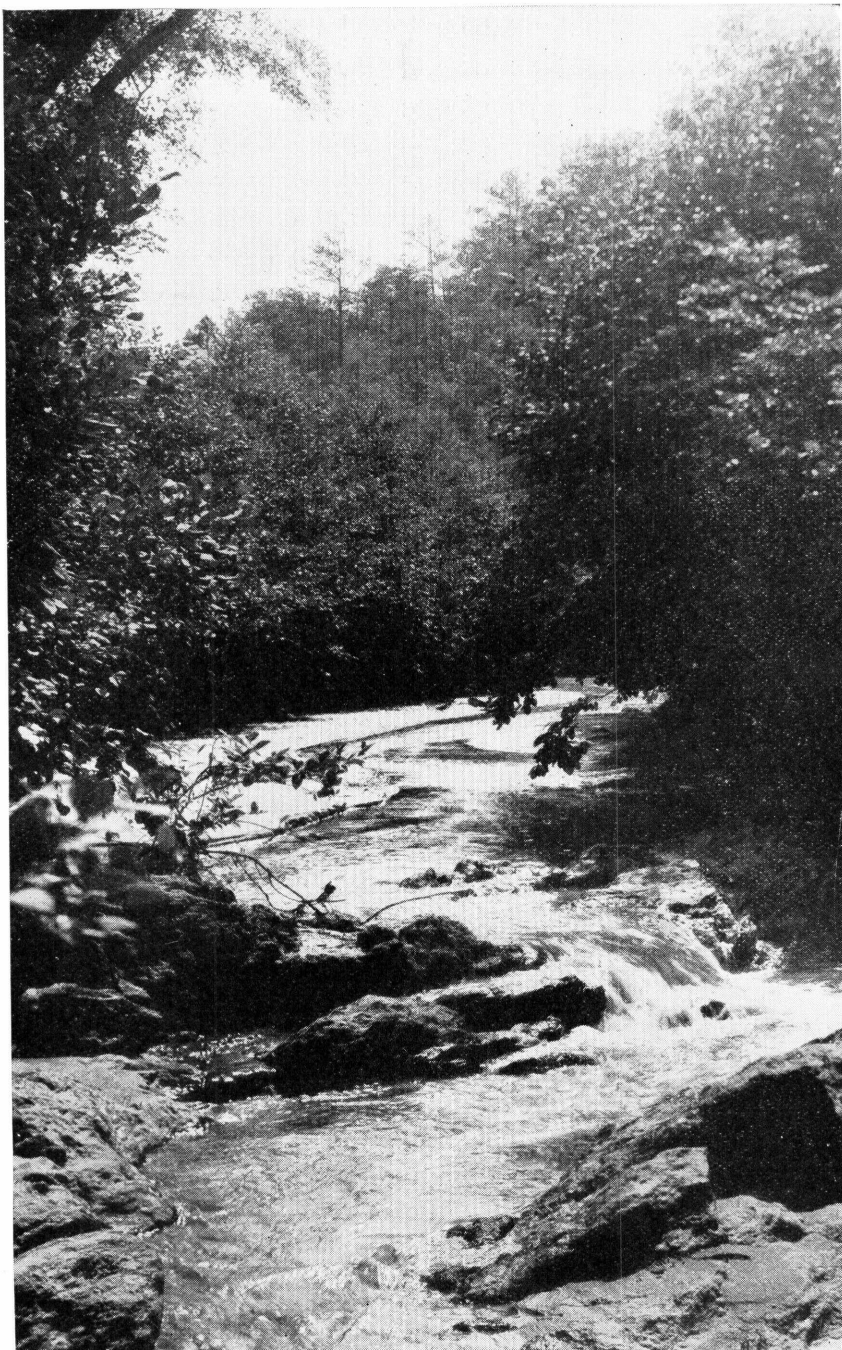

FIGURE 1.—*Streams flowed clear and quietly.*

When the Land Was New

WHEN MEN CAME to the Piedmont to farm less than two centuries ago they settled near the streams, where the most fertile lands of the region lay. They judged the value of the land by the type and luxuriance of the native vegetation. According to tradition the first settlers in the southern Piedmont accepted as their measure of soil productivity the size of the cane growing near the streams. If the cane grew only to the height of a man's head they considered the soil of ordinary quality and passed on in search of a better place to make their homes. But when they found cane more than 20 feet tall they knew the land was fertile, and built their cabins.

In their valley homes they were safe from the threat of turbulent and destructive floods. The upland slopes were forest-covered, and the soils, loamy, humus-filled, and granular, absorbed water like a sponge, filtering it slowly to streams that flowed clear and quietly (figs. 1 and 2).

Along the streams and in the valleys there flourished, besides the cane, trees of ash, yellow poplar, oak, hickory, sycamore, beech, birch, and, in places, black walnut. The land was new and beautiful, its landscape rich and luxuriant.

The principal trees of the highlands were pine, oak, hickory, and chestnut. There was little underbrush in the denser woods. Trees were large and spaced so widely that wagons could pass between them. Where there was light and space, grass and wild legumes carpeted the forest floor. Here and there was a patch of cane, a plant now rarely seen on the uplands.

William Byrd II, head of a surveying party in 1728, described the country along the border between North Carolina and Virginia:

> The soil we passed over this day was generally very good, being clothed with large trees of poplar, hickory, and oak. Another token of fertility is that wild angelica grows upon it.

Colonel Byrd reported that his party did not want for food. There was plenty of wild turkey, deer, and partridge for the hunting and wild

FIGURE 2.—*When the white man came to the Piedmont to farm, the upland slopes were forest-covered. The soils were loamy and granular and filtered rain water slowly to the streams.*

fruits everywhere—cherries, plums, and grapes and other seed-bearing vines, shrubs, and trees. The colonel was pleased with the country.

> The air is wholesome and the soil is equal in fertility to any in the world. Charming valleys bring forth like the lands of Egypt without being overflowed once a year. Grass in the river sections grows as high as a man on horseback, and the rivers roll down their waters to the sea as clear as crystal, their bottoms covered with a coarse gravel spangled very thick with shining flakes of mica.

Since Colonel Byrd wrote these lines, the original forests of the Piedmont have largely disappeared, to be replaced principally by native pines, the first step in a forest rotation which nature employs in this region to reclaim eroded, abandoned fields. Many of the once fertile bottom lands have been covered by an overwash of comparatively infertile sand and other eroded material; and more frequent overflows resulting from channels choked with erosional debris have converted much of these alluvial lands to a condition of swamp or semiswamp.

In pioneer times sandy loams were the dominant soil types in the Piedmont. They lay over the region to a depth of 7 to 15 inches. Held in place by the binding roots of plants, and covered and protected by an

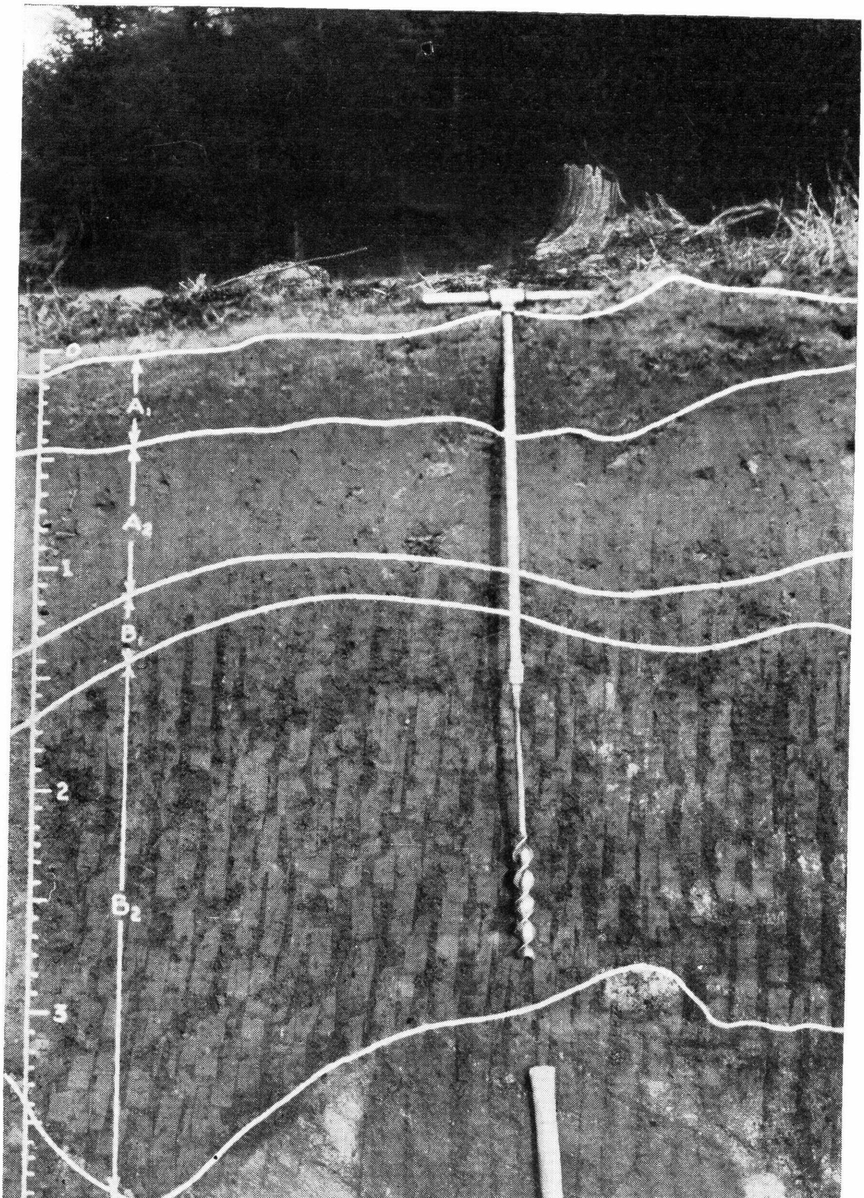

FIGURE 3.—*Humus-charged sandy loams lay over the region to a depth of about 6 to 8 or 10 inches* (A_1 *and* A_2), *the product of thousands of years of nature's patient labor. Out of reach of spade or plow lay a red clay of entirely different character* (B_1 *and* B_2).

absorbent layer of decaying vegetable matter, these soils lay where they had formed from the ancient crystalline rocks which underlie most of the Piedmont Plateau. Nature had worked, in her patient, unhurried way, for thousands of years to form these loamy topsoils. Here and there, in small patches of virgin forest and in level places not subject to excessive soil washing, these loamy soils may still be seen.

When found in a patch of original forest, these sandy loam soils are covered by a thin layer of moldering leaves. Underneath the mold there is a layer of light-textured soil, about an inch or two deep and containing enough organic matter to give it a dark color. Below, to a spade's depth on the level areas and about 7 inches on the slopes, the soil is pale yellow or grayish yellow in color. Out of reach of spade or plow lies a red clay containing some sand. Below this red clay soil, which varies in depth from 2 to 20 feet, is a layer of decomposing rock which must weather for undeterminable centuries before it may properly be called a soil (fig. 3).

Measured Soil Losses

SOME 30 YEARS AGO two young soil scientists were sent by the Bureau of Soils of the United States Department of Agriculture to survey and map the soils of Louisa County, Va. Arriving in that old Piedmont country, which from colonial times had been a flourishing farming community, they were asked by their chief, the late Milton Whitney, to ascertain the cause of the reputed low fertility of the land. After studying and mapping the soils for some weeks the two young soils men discovered the principal cause. Wherever the land had not been cleared of forest, the topsoil, they found, consisted of a good depth of a mellow loam or sandy loam; yet only a red clay or a red clay loam was to be observed on many slopes that had been cultivated long enough for the stumps to disappear. They soon came to realize that the original soil on many sloping fields had been removed down to, or near to, the second layer of soil, the red clay, by erosion. Continuing to survey and map Piedmont soils through the years, they discovered that this loss was not restricted to Louisa County, Va., but that it affected more than half of the 50 million acres of land that lies in the Piedmont Plateau extending north from central Alabama to within hail of New York City.

Incredible as it may seem, even today the nature of the process by which such great quantities of soil are lost from cultivated fields is not widely understood nor widely recognized. To most people the gully stands as the symbol of erosion, and it is; but there is a type of erosion more costly even than gullying that does not announce itself to the casual eye. Rain water flowing from a clean-tilled field is always muddy, never clear. Laden with soil material, it is red, yellow, or gray, according to the color of the soil over which it has flowed. Thus each rain of sufficient intensity to produce water run-off carries with it a thin layer of the surface soil, and this process, repeated again and again, is called sheet erosion (fig. 4).

FIGURE 4.—*Slopes were stripped of their forest cover and planted to clean-cultivated crops. The topsoil began washing away.*

Sheet erosion affects large areas, often entire fields, and goes on slowly, so slowly that it is seldom observed until spots of clay or rock seem suddenly to thrust themselves above the ground. When erosion has advanced to this stage the damage is done; the thin surface of topsoil is on its way to the sea, and in its place a red subsoil, fine-textured, compact, humus-lacking and impervious, lies exposed to the plow. Some Piedmont areas whose records are known lost all of their topsoil by this process within the short space of 30 years.

One of the first acts of the Soil Conservation Service after it was created in 1933 was to survey the Nation's soil resources to determine the extent erosion had impoverished or depleted them. When a national report was assembled the Piedmont proved to be one of the most severely eroded areas in the United States. What the surveyors found bore out the assumptions advanced by the two young soil scientists who had visited Louisa County, Va., 30 years before.

This preliminary survey—a reconnaissance erosion survey—completed in 1934, is the best measure we have of the extent to which soils in the Piedmont have been impoverished or depleted by erosion. There are, in that part of the Piedmont lying in the five States of Virginia, the Carolinas, Georgia, and Alabama (fig. 5), some 40 million acres of land. The survey indicates what has happened to this land. Although only rough approximations, the figures, even when accepted with reservations, are astounding to those who have not made a close study of Piedmont soils.

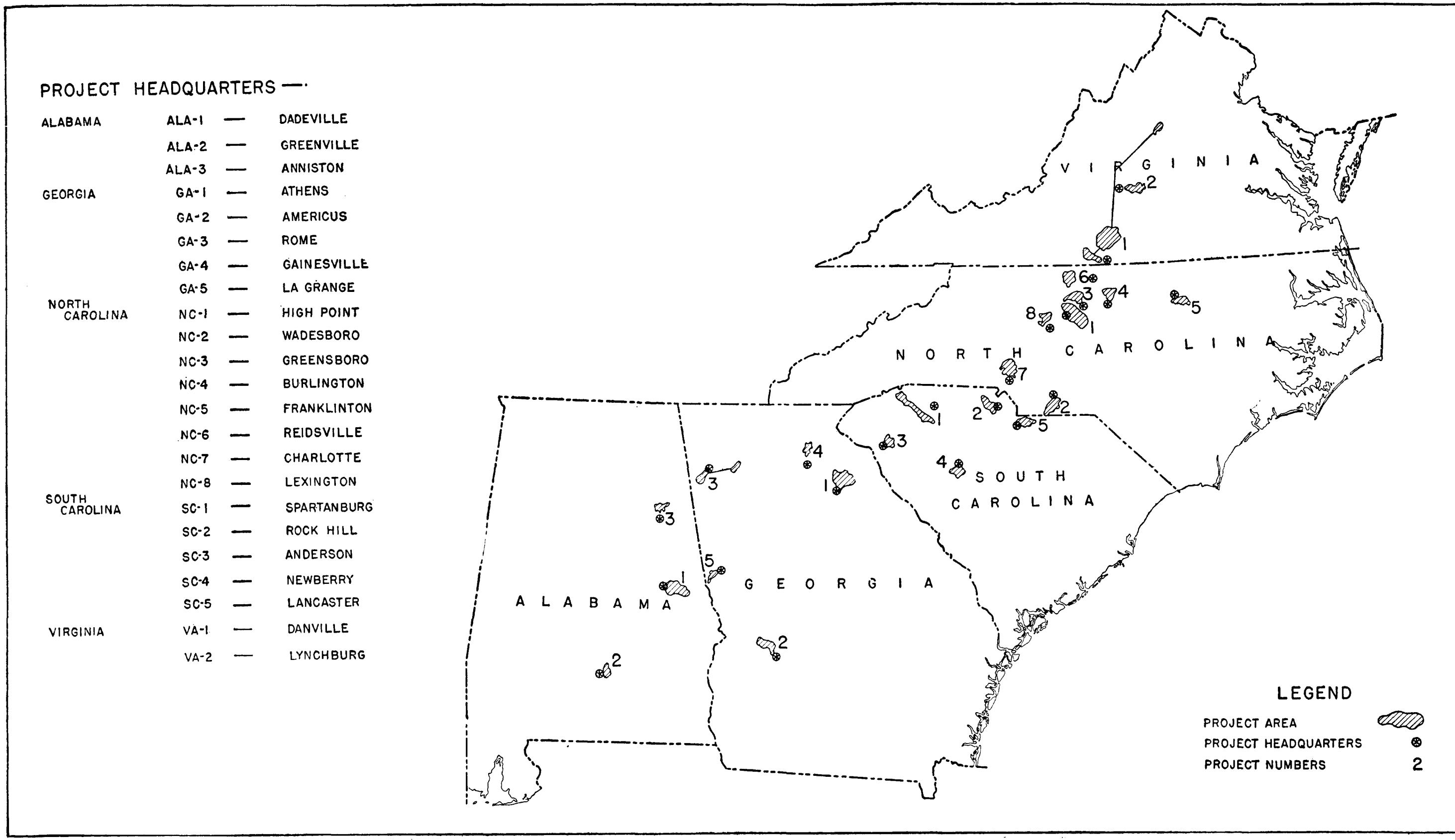

FIGURE 5.—*Map of the Piedmont area, showing the location of demonstration projects.*

Three-fourths to all of the topsoil has been washed from approximately 12 million acres, or 30 percent of the area; and great sectors of this area are disfigured and defaced by gullies. A large part of these 12 million acres has been retired from cultivation; much of it cannot again be cultivated for generations, it is so badly cut to pieces.

Most of the cultivated land of the remaining 28 million acres has suffered in varying degrees from erosion, and in many places, as a result, farming is of a patchy nature.

Going south in the Piedmont through Virginia, the Carolinas, Georgia, and into Alabama, one notices that the degree of damage wrought by erosion becomes progressively severe. In the Virginia Piedmont about 10 percent of the land has lost three-fourths or more of its topsoil; the figure rises to 20 percent for North Carolina, and to 40 percent for each of the States of South Carolina, Georgia, and Alabama.

There are countless gullies in the Piedmont—millions of them. Gullies are of all kinds: incipient ones, or washed places in cultivated fields; deep and narrow V-shaped clefts in the earth; yawning chasms huge enough to swallow a train of railroad cars. They touch the whole of the Piedmont; no county is free from this trade mark of a reckless agriculture. Air photographs reveal thousands of them. When the South Tiger River demonstration area, comprising some 120,000 acres in South Carolina, was photographed, surveyed, and mapped, 1,500 gullies more than 8 feet deep were revealed by the camera.

Land is seldom retired from cultivation in the Piedmont until erosion, either of the sheet or gully type, reduces productivity to such an extent that it is no longer profitable to cultivate it (fig. 6.). Advanced erosion therefore undoubtedly accounts in a large measure for the retirement from cultivation of some 50,000 farms, in the period between the censuses of 1920 and 1930, in the Piedmont of the Carolinas and Georgia.

It is possible to make fair crops, and sometimes good crops, on some of the red subsoils of the Piedmont, but when the red subsoil is removed down to the underlying disintegrating rock, the land is of value only for growing trees. Long before this stage of erosion is reached, however, gullying renders the land unfit for cultivated crops.

In some types of soil gully cutting goes on slowly; in others—especially in those derived from granitic rocks—the process goes on slowly only until the clay subsoils are worn through, and then when the soft "rotten" or disintegrating rock which underlies the clay is reached, becomes rapid. The unstable substratum washes out from under the clay, and the clay cracks and tumbles into the gully and so is started on its journey toward the sea. There is a great amount of gully washing of another sort in the region, principally in such plastic clays as the Iredell and White Store soils, which abrade rapidly. Soils of this type have been known to "wash down the

river" within a dozen years after the cover of forest was removed. Gullies forming in these stiff subsoil lands are usually V-shaped, and more easily controlled than those of the caving, undercutting type, which are U-shaped.

It is certain that there were no gullies in the Piedmont when it was a forest. No one has ever discovered gullies in the patches of virgin timber still standing, except those washed out by excessive amounts of water entering from cleared fields lying higher on a slope. The millions now found testify mutely to the recklessness of Piedmont agriculture.

FIGURE 6.—*After a period of continuous cropping, lands become worn, bare, and gullied, no longer fit for any growth other than broomsedge, briers, and native pine.*

The Piedmont is but one of many regions in the United States where soil wastage by erosion has wrought disaster to the land. In some sections of the country erosion on erodible soils is proceeding at even a faster rate than in the Piedmont. The widespread costly effects of erosion within the eastern foothill country of the Appalachians have resulted largely from the longer period these lands have been farmed and from the abuse of the widespread practice of growing clean-tilled crops too continuously. In spite of these abuses, much good land remains through most parts of the region—land that must, for the security of the population, be protected from further impoverishment bv erosion.

Buried Bottom Lands

RIVERS in the Piedmont once ran clear. Fed by waters slowly released from absorbent soils on wooded slopes, they maintained a fairly even flow, and carried little silt. In colonial times planters from miles around were attracted to the rivers for the sturgeon fishing. Rivers now flowing through the Piedmont are red with mud and the patient angler feels amply rewarded nowadays if he hooks an occasional catfish or carp.

After each rain the intensity of the color of the streams deepens, for the swifter waters carry heavier loads of soil. Since the forests have been cleared from much of the land, water instead of seeping down slopes through granular soils and the spongelike forest mold and litter, rushes headlong over bare, cultivated slopes studded with countless areas of comparatively unabsorptive erosion-exposed clay subsoil. Nowadays after a heavy rain streams rise quickly to flood stage. After the rain ceases the flood waters quickly recede. The Tiger River near Woodruff, S. C., for example, was discharging through the gaging station of the Geological Survey at the rate of 155 cubic feet a second one June evening. It rained, and the stream rose. Before midnight water was passing through the gages at the rate of 3,720 cubic feet a second. Within a 4-hour period the flow of water had increased to 24 times the volume of the afternoon; yet by the following evening the stream had returned to almost normal height.

The energy of rushing water enables it to carry great loads of soil. When the velocity of a stream is doubled, its power to carry silt and debris theoretically is multiplied 64 times. Some of this silt is carried out to sea, but much of it is deposited over the bottom lands of the stream valleys or in stream channels and reservoirs, after the velocity of the water slows.

Surveying parties in the eighteenth century reported in their journals that grass and cane grew high in natural meadows along the streams. Twentieth-century surveying parties report differently. Much of the natural meadowland has disappeared, they find, under cover of layers of

FIGURE 7.—*The rain-absorbing forests were gone, and water rushed off the bare, cultivated hillsides. Floods became frequent and destructive.*

FIGURE 8.—*Flood waters brought erosional debris down from gullied lands above, burying the productive bottom soils under sand and other debris of erosion.*

silt and gravel deposited by streams when in flood (fig. 7). Streams clogged with debris overflow quickly; and after each heavy rain a new layer is laid down, burying the original topsoil deeper underground. Such clogging of a stream not only causes it to cut a new and meandering channel or several channels, but it raises the water table (fig. 8). If the water table is raised high enough, good land becomes swamp. So general is the damage wrought by obstructions in streams that soil surveyors have classified more than half of the bottom lands of the southern Piedmont as essentially nonarable meadow—that is, wet land subject to frequent overflow and covered for the most part with willow, alder, sweetgum, rushes, and blackberry. These are the same lands that moved an early inhabitant to such enthusiasm as to write: "The land brings forth corn spontaneously without the curse of labor and so wholesome that none who have the happiness to eat of it are ever very sick, grow old, or die."

Dwindling Water Power

IN A VERY EARLY PERIOD the Piedmont became famous for its water-power resources. One of the first activities of the early settler was to build a mill to grind his grain. Later, when cotton was introduced into the South and the invention of the cotton gin made possible the production of cotton on the grand scale, the first great industrial centers of the region sprang into being along the fall line, the eastern and southern boundary of the Piedmont separating the high interior from the low coastal plain. Many of the available water-power sites of the region were developed. Dams were erected to impound water in reservoirs. Textile mills were built and water power whirled their spindles.

But the useful life of a reservoir in an area seriously afflicted with erosion is short. Many of the smaller reservoirs passed, within two or three decades, through a cycle of usefulness to abandonment. Many filled with silt; their dams were raised and they filled again (fig. 9). On the Deep River below High Point, N. C., 11 water-supply reservoirs have been abandoned in the last 50 years. Only 2 mills of the original 13 can store sufficient water behind their dams to drive their turbines during low-water seasons. Throughout the Piedmont there are scores of these smaller mills, once the source of community power and wealth, that now, lacking adequate water storage, are useful for only 2 or 3 hours at a time.

Studies of siltation of 56 of the larger reservoirs in the southern Piedmont reveal that 13 of them are now completely filled with silt. The average useful life of these has been 30 years, and the maximum life 36 years. The 13 dams are first-class concrete and masonry structures representing large initial investments. More than half of them are 30 to 50 feet high and originally impounded water to a distance of 4 to 7 miles up valley. On examination, all reservoirs that received drainage from agricultural piedmont areas were found filling with silt and other erosional debris at a rate in accord with the conditions of erosion in the watersheds.

FIGURE 9.—*Reservoirs filled quickly with silt and lost much of their storage capacity. Many Piedmont reservoirs filled in less than 30 years.*

Large and small reservoirs pass through the same cycle. They all, in time, fill and lose their usefulness for water storage; no economical method of clearing them has been devised.

The valley of the Tallapoosa River in Alabama is blocked by a dam 168 feet high. Built in 1927, the dam backs water 23 miles up the valley to form Lake Martin. Measurements of the extent of silting in this lake were made in 1932 and 1934. In the interval a delta 30 feet deep, 600 yards long, and 100 yards wide had formed up the valley. In two seasons flood waters had deposited 600,000 cubic yards of sand.

In contrast there is the Green River Reservoir near Tuxedo, N. C., which is fed by waters from a forested area. The few cleared and cultivated areas indicate that the soils are fully as erodible as those in the Piedmont. The waters in this reservoir are beautifully clear except in a bay along the northern side where drainage enters from cleared land and from a graded road. No extensive flats have developed at the head of the reservoir 7 miles above the dam, and when the water is well drawn out it may be seen that the total accumulation of sand is small. The plant foreman, familiar with the reservoir since its construction in 1918, remembers seeing the water turbid only a few times.

Awakening Interest in Soil Defense

NOT MUCH WAS SAID or done about saving soils in the Piedmont country until after the Revolution. Home from the war, farmers had time to observe their fields, and one of the first evils they recognized was soil washing. The writings of Washington, Jefferson, and Madison mention it.

Washington and Jefferson, both progressive farmers, were among the first to work out satisfactory crop rotations in an effort to forestall soil exhaustion. They introduced a 7-year rotation, making abundant use of clover, and followed it closely. They grew little corn; both were prejudiced against this crop, believing it to be especially exhausting to the soil. Washington, fearing soil exhaustion, restricted his plantings of the most prominent row crop of his day, tobacco.

Jefferson was one of the first advocates of contour tillage. He wrote to a friend in 1813 about his farm in Albemarle County, Va.:

> Our country is hilly and we had been in the habit of plowing in straight rows, whether up or down hill, in oblique lines, or however they lead, and our soil was all rapidly running into the rivers. We now plow horizontally following the curvature of the hills and hollows on dead level, however crooked the lines may be. Every furrow thus acts as a reservoir to receive and retain the waters, all of which go to the benefit of the growing plant instead of running off into streams.

But Washington and Jefferson were exceptional farmers. Few adopted their farm practices. Throughout the Piedmont the type of farming was determined more by habit than by reason. In the central Piedmont the colonial system of cropping persisted. Farmers cleared new land, grew tobacco for about 3 years, and then planted the land continuously to wheat and corn as long as it produced 5 or 6 bushels of wheat or 10 or 12 bushels of corn to the acre. After the land became too worn to produce even these meager yields it was thrown out to be rested for a period of years, and a new patch was cleared.

Washington, who owned large holdings of land in piedmont Virginia, deplored the system, but he found himself powerless to bring about reforms;

in fact, in his absence from home his own estate suffered from soil impoverishment quite as much as the estates of his neighbors. In 1797 Washington, in replying to a letter of criticism of American agriculture from an Englishman, William Strickland, wrote:

> Your strictures on the agriculture of this country are but too just. It is indeed wretched; but a leading, if not the primary cause of its being so is, that, instead of improving a little ground well, we attempt much and do it ill. A half, a third, or even a fourth of what we mangle, well wrought and properly dressed, would produce more than the whole under our system of management; yet such is the force of habit, that we cannot depart from it. The consequence of which is, that we ruin the lands that are already cleared, and either cut down more wood, if we have it, or emigrate into the Western country. I have endeavoured, both in a public and private character, to encourage the establishment of boards of agriculture in this country, but hitherto in vain; and what is still more extraordinary, and scarcely to be believed, I have endeavoured ineffectually to discard the pernicious practice just mentioned from my own estate; but, in my absence, pretexts of one kind or another have always been paramount to orders.

Shortly after the Revolutionary War, cotton came to the piedmont of the Carolinas and Georgia and brought with it a short period of prosperity. But here too the colonial system of land management persisted, and as a result much land became exhausted, washed, and gullied. By 1825, according to early writers, so much land first devoted to cotton or tobacco in parts of the Piedmont was gullied and abandoned to broomsedge and pine that farmers pushed their clearings to the higher ridge lands which their fathers had deemed not worth cultivating.

Only after little new land was left to clear did farmers arouse themselves to an interest in soil saving. The farm journals during the period following 1830 abound in suggestions, and some of the defense measures proposed were given trial. At this time horizontal plowing, as practiced years before by Jefferson, was introduced into the southern Piedmont, and hillside ditching, then in vogue in Europe, excited further interest. The object of hillside ditching was to provide drainageways at intervals to intercept water flowing across slopes and carry it off to the sides of fields. Before a storm of ridicule these simple defense measures gained popularity and by 1860 were widely employed. In 1850 Daniel Lee, a visitor from the North, wrote:

> In recalling to mind the many plantations which we visited in South Carolina and Georgia, nothing has left so enduring an impression as the skillful manner in which hillside ditches were constructed, to prevent washing of the surface soil. In this matter, the planters of these States have excelled all we have witnessed elsewhere in the Union, and we have seen most of it.

Planters made some slight progress in this period with rotations. The more progressive operators adopted a rotation of cotton, corn, and small grain, discarding the practice of single-cropping the land continuously. Others who preferred to grow no small grain adhered to a rotation of cotton, corn, and "rest." Fertilizers were hardly known. According to Solon Robinson, an agriculturist of the period, "resting" was the only renovating process known to most planters. By the fifth decade some planters were

applying compost, cottonseed, and guano (bird fertilizer from South America) to their lands.

About this time terracing came into more widespread use, especially in the southern Piedmont. Although some terraces had been built prior to the fifth decade, the practice was employed only rather ineffectively throughout the greater part of the nineteenth century. Terraces were crude and were often constructed in such a manner, placed on such steep, erodible slopes, or so neglected, as to be more harmful than helpful. Built solely to reduce the rate of off-flowage from the land, the earlier terraces frequently were constructed with so much fall, often as much as 3 or 4 feet in 100, that water flowed with sufficient erosive force to cut through at the bends and other weaker parts of the embankments. Once they had broken, these narrow ridge terraces, so narrow that a man could step over one (fig. 10), served only to concentrate the water, causing gullying with each heavy rain. Since little attention was given to caring for water at terrace ends, gullies formed at these points.

Little effort was expended in maintaining terraces. They often filled, and water flowed across them, descending over the accentuated slope on the downhill side in waterfall fashion and gouging out gullies. Thousands of fields have been abandoned entirely or in part, especially throughout the Piedmont of South Carolina and Georgia, because of gullies forming from neglected terraces. Reconnaissance erosion surveys indicate that at least 2 million acres of land in Georgia, all at one time terraced, have been abandoned to old-field pine. Some of the terraces in these old fields were well built on proper gradients; their failure was due either to neglect or to excessive steepness of the fields, or to both factors.

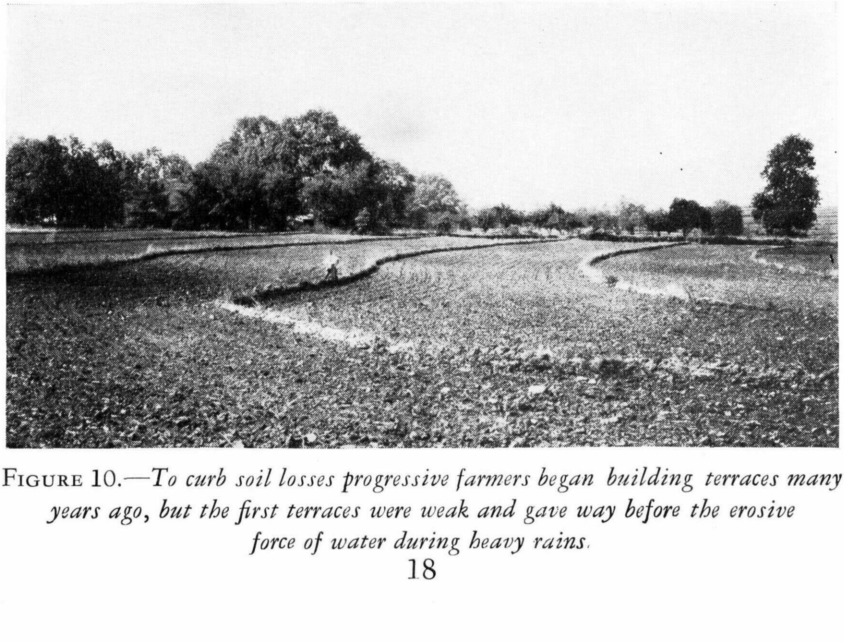

FIGURE 10.—*To curb soil losses progressive farmers began building terraces many years ago, but the first terraces were weak and gave way before the erosive force of water during heavy rains.*

Modern Measures of Soil Defense

THE STRUGGLE with erosion is ageless. Civilizations fought it, lost, and disappeared. In North America the struggle began on the erodible soils of the Piedmont immediately after the forests were cleared. It was in the southern Piedmont that American farmers, as a group, first resorted to contour cultivation and terracing. Even in the central Piedmont, where the soils are only somewhat less erodible, these valuable aids are just now coming into use on many farms. But despite these pioneer efforts soil losses continue at an alarming rate. It is becoming increasingly apparent, as field after field and farm after farm are abandoned, worked out like an exhausted coal mine, that something more must be done if Piedmont farmers are to save their soils, and retain a certain measure of economic independence. Defense measures must be taken generally and without delay, if the valuable remaining areas are to be preserved. For the safety of the region, it is not enough that pine trees grow on these eroded lands—useful as pine forests are for firewood, lumber, paper, and conservation of soil and water. Much land will continue to be required for cultivation.

For many years men have turned their thoughts and directed their energies toward devising new ways to husband the soil. Much has been accomplished, notably in the design of mechanical structures such as terraces. But recently, with the realization that nature can be made to work for man rather than against him in a program of soil husbandry, a new direction has been given to erosion-control investigations. It may be observed that nature resorts to vegetation in its various forms not only to preserve and enrich the soil but to heal the wounds of the land. Nature teaches that soils may be protected from excessive washing by natural means—by rotating crops intelligently, by planting crops in strips, and by the judicious use of fields according to their slope and tendency to erode. No longer must the twin measures of terracing and contour cultivation, use-

ful as they are, be made to bear the full brunt of a program to hold our soils.

In the pages immediately following, the effective soil-saving practices, old and new, that have withstood the tests of practical use, are separately described. Further on, in a section about the demonstration program of the Soil Conservation Service, headed "Etching the Story on the Land", is told the story of the merging of the various measures into a single farm program of defensive soil husbandry.

TERRACING

Priestly Mangum, a farmer at Wake Forest, N. C., made the first great contribution to modern terrace design, creating the type of terrace which bears his name. His terraces, built late in the nineteenth century, were the first of the broad-base type and, in the broader sense, the first that were really more helpful than harmful, from a long-time point of view, in controlling erosion.

Until Mr. Mangum devised the broad-base terrace the usual farm terrace consisted of a few furrows thrown together on the approximate contour of a sloping field. This type of terrace did much, it is true, to slow the flow of water down a field and cause it to drop its soil load along the terrace line; but it was not strong and, in the end, too frequently broke under stress of heavy rains, releasing water with such a rush that gullies cut across and below the terrace. The Mangum terrace is stronger and broader—12 to 15 inches high and 18 to 24 feet broad (fig. 11). It may be described as a levee of earth built to direct water safely from a field and to conserve water by causing it to sink into the ground above the embankment.

About 1924 M. L. Nichols, head of the department of agricultural engineering at the Alabama Polytechnic Institute, designed a broad-base terrace superior in some respects to the Mangum terrace for certain soils. The Nichols design has since become popular in the southern Piedmont area, notably in South Carolina, Georgia, and Alabama. It is the type now being built generally on the Service's demonstration areas in these States. The Nichols terrace is, essentially, a broad, shallow ditch buttressed on the lower side by an embankment of earth. It is built entirely from the upper side by moving the soil down from above. Most of the water behind the terrace flows in a channel below the original surface of the ground, and complete terrace failures therefore seldom occur. The Mangum terrace differs in that it relies more upon a broad embankment of earth to hold the water. In constructing the Mangum terrace approximately one-third of the soil is moved uphill and two-thirds downhill. The Mangum terrace may be roughly described as an intercepting and absorption structure, the Nichols terrace as an intercepting and drainage structure. Soil character-

FIGURE 11.—*The modern broad-base terrace is a stronger sort, 18 to 24 feet broad and 12 to 15 inches high. It intercepts water and directs it safely from the field.*

istics and costs determine which is used. On the deeper sandy soils, such as those of the Atlantic and east-Gulf Coastal Plain, the Mangum terrace, although it costs more to build, is preferred. For most Piedmont soils, however, the Nichols terrace is considered superior.

The original Mangum terraces were of uniform grade along their entire length, no provision was made for the increasing quantity of water that must accumulate in a channel of a terrace as it approaches its outlet. The grade of the modern broad-base terrace is variable; that is, the grade becomes progressively greater as the terrace approaches its outlet. In one series of experiments 15 to 30 percent more soil was lost from the ends of terraces having a uniform grade of 4 inches in 100 feet than from terraces having a variable grade. Great care is taken to insure a proper grade in the terrace channel in building the modern terrace, and by proper plowing methods these terraces can be effectively maintained (fig. 12). The grade of the terrace is determined accurately by use of surveyors' instruments. In one type of design the fall of the channel is one-half inch in the first 100 feet, an inch in the second 100 feet, and so on, increasing a half inch in 100 feet until a maximum fall of 6 inches in 100 feet is reached near the lower end. Some engineers prefer to build terraces level for the first 300 feet and then allow one additional inch of fall in each 300 feet thereafter until a maximum drop of 4 inches in 100 feet is reached.

Terracing is based on the principle upon which all of the more successful erosion-control measures depend; slowing the speed of flow of water

causes it to lose most of its power to carry a soil load. Erosion is always greater on long slopes than on short slopes when fields are clean-cultivated. On the longer slopes the water, unless it is impeded in its flow by vegetation or soil barriers, gains enough velocity to cut out and carry off greater loads of soil than it does in flowing down a shorter slope.[1]

A terracing system takes advantage of this character of water flow by, in effect, breaking a long steep slope into a series of short moderate slopes. Terraces are spaced so as to break the flow of water before it can accelerate to an erosive speed. There are no hard-and-fast rules of thumb for spacing

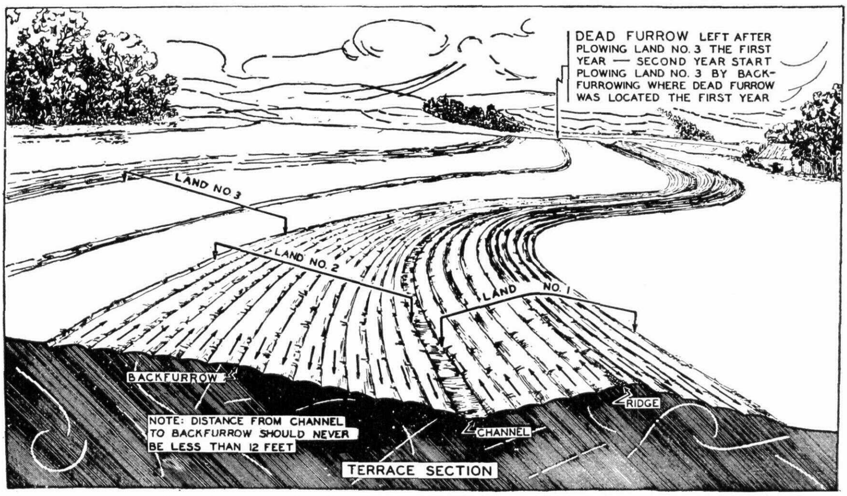

FIGURE 12.—*By plowing the land properly the modern terrace may be effectively maintained. The arrows in the drawing indicate the direction of the furrows in a properly plowed terraced field. The width of land no. 2 is varied each time the field is plowed.*

terraces. In general, they are spaced closer as the slope becomes steeper. As a guide for terracing slopes in the southern Piedmont, Alabama Polytechnic Institute Circular 148, Terracing in Alabama, recommends spacing as shown in Table 1.

The spacings recommended in table 1 are based on the original investigations of C. E. Ramser. In field work, spacings frequently differ from those given. On tight soils, or on very erodible soils, the distance between terraces may be decreased as much as 25 percent. On absorptive soils spacing may be safely increased an equal amount.

[1] In some instances the character of the soil itself materially affects this general rule. On some soils there appears to be involved a peculiar loading and unloading process as water flows across slopes, and in some instances this factor causes a greater loss, within limits, of soil from shorter slopes.

TABLE 1.—*Spacing recommended in the construction of terraces*

Slope of land in feet per 100 feet (feet)	Vertical distance or the drop between terraces		Horizontal distance between terraces	Slope of land in feet per 100 feet (feet)	Vertical distance or the drop between terraces		Horizontal distance between terraces
	Feet	*Inches*	*Feet*		*Feet*	*Inches*	*Feet*
1	2	6	180	7	4	0	57
2	2	9	140	8	4	3	53
3	3	0	100	9	4	6	50
4	3	3	80	10	4	9	48
5	3	6	75	12½	5	4	43
6	3	9	63				

Little thought has been given, in the past, to the disposal of water once it was diverted from a field by a terrace. The record of this oversight is written in a havoc of gullies throughout the Piedmont and other regions. Water concentrated by terraces is the direct cause of gullying in far too many instances; in fact, terraces frequently come to an end at the brink of gullies extending along farm property lines. Many country roads have been damaged and some even ruined by reckless dumping of terrace water into roadside ditches. There are roads in the Piedmont that have been relocated four or five times; each time gullying rendered them unsafe (fig. 13).

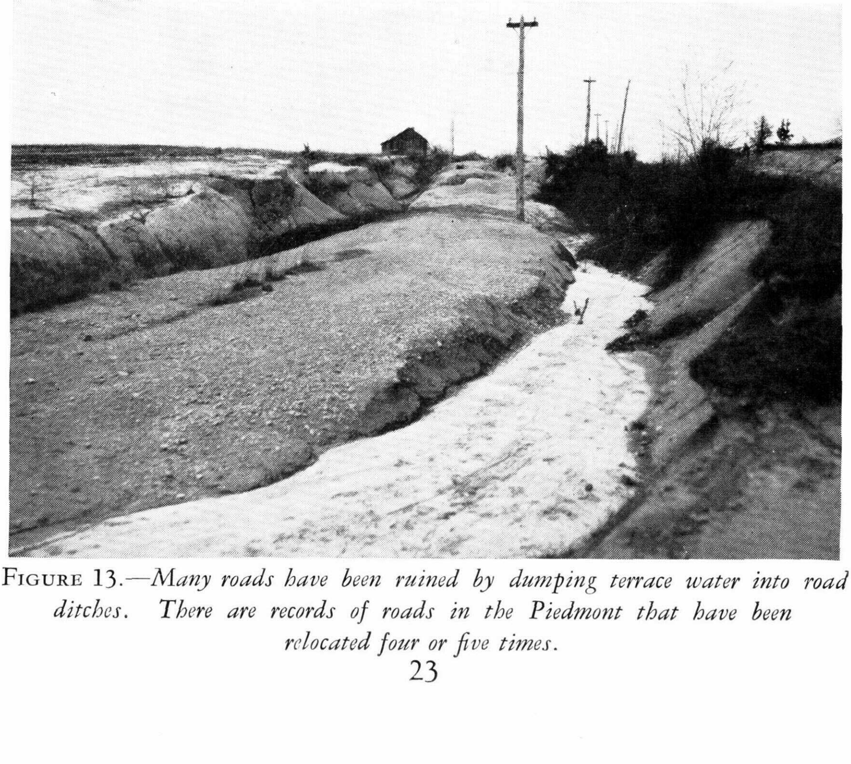

FIGURE 13.—*Many roads have been ruined by dumping terrace water into road ditches. There are records of roads in the Piedmont that have been relocated four or five times.*

FIGURE 14.—*A terracing system for a farm is not considered complete until the water is directed from a field through a system of protected waterways.*

In Soil Conservation Service demonstration areas a terrace system is considered complete only when the water may be safely conducted to a stabilized grade through a system of protected waterways (fig. 14). Water is dumped into a road ditch only when no other outlet can be found, and even then the road ditch is protected from gullying by a series of baffles. Frequently a protected waterway is built parallel to the road if it is thought that drainage water may damage it (fig. 15). The laying out and the protection of these field waterways is perhaps the most difficult job confronting the man who plans a terrace system.

Several types of waterways are proving successful under field conditions in demonstration areas. One method that is becoming increasingly popular is to lead the terraces to a natural draw in the field. This draw is seeded to a thick-growing meadow crop such as a mixture of grasses and legumes. For lesser slopes these meadow strips are working out splendidly (fig. 16). Terrace outlets on steeper slopes demand more protection than vegetation alone always can give, for the large quantity of water often discharged into such outlets flows with great erosive force (fig. 17). To prevent them from growing into gullies, under the cutting force of the concentrated water, these outlets should be protected with vegetation or reinforced with a series of baffle dams throughout their length (fig. 18). Dams may be made of concrete, stone, fence posts and wire, creosoted lumber, or of any suitable material available on the farm. A safe method

of carrying water from terrace outlet channels is to direct it over a masonry weir onto a stabilized drainage bed (fig. 19).

Terracing yields better results on some types of land than on others. Terracing alone is probably adequate for stabilizing some soils in fields of gentle slope; on other slopes and other soils, unless the practice is

FIGURE 15.—*A protected waterway built parallel to a road to carry terrace water protects valuable public property.*

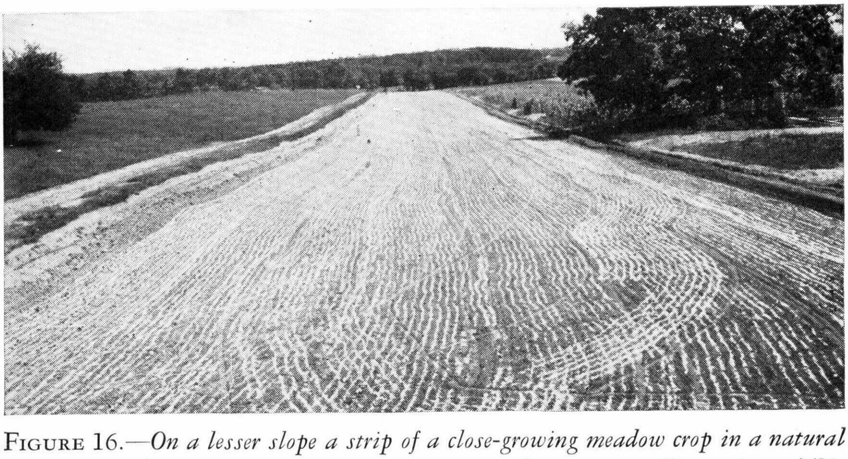

FIGURE 16.—*On a lesser slope a strip of a close-growing meadow crop in a natural draw receives terrace water, impedes the flow, and prevents gully cutting. This strip of limed land is seeded to a mixture of legumes and grasses.*

FIGURE 17.—*Bermuda grass sod flumes under a net of chicken wire are used to lower water from one level to another.*

supported by other measures such as crop rotation, planting winter and spring cover crops, and strip cropping, terracing fails to provide stability. For example, the average annual loss of soil over a period of 4 years from Shelby loam on an 8-percent slope in a north-central Missouri experiment, proceeded at a rate of 67 tons an acre where corn was grown continuously on a field cross section of 72.6 feet. Here the mean annual rainfall was 40 inches. In contrast, the corresponding soil loss from Cecil sandy clay loam in central North Carolina on an area of identical size and for the same length of time was only 15.6 tons an acre where cotton was grown continuously, even though the slope was greater (10 percent) and the rainfall heavier (45.6 inches annually). Both plots were completely protected by steel guards from intake of water from above or from the sides (fig. 20).

Since the distance between some terraces is about as great as the length of these cross sections, these losses represent very nearly the losses that would take place on such soils regardless of the type of protection from above, whether vegetative or mechanical. In the one instance terracing would be far more effective than in the other. In both instances, however, the losses were much less than where the cross-sections were unprotected from above.

FIGURE 18.—*To protect them from growing into gullies, terrace outlet channels are reinforced by a series of baffle dams set crosswise to the direction of water flow.*

CONTOUR TILLAGE

Although contour tillage probably owes its origin in this country to the ingenuity of Thomas Jefferson and was practiced first in Virginia, this highly effective erosion-control measure is, even today, infrequently employed in many parts of the Old Dominion. Even in the vicinity of Shadwell and Monticello, Jefferson's own neighborhood, contour cultivation is today almost an unknown farm practice. Most farmers prefer

FIGURE 19.—*Water may safely be dropped from a terrace outlet channel into a stabilized drainage bed over a masonry weir.*

straight rows in that part of the State, and frequently point them up and down a slope, thus creating a condition under which a field is least able to hold its soil.

In much of the Piedmont farther south, in the cotton country, contour tillage is today an almost universally accepted farm practice, although the contouring of many farmers is not perfectly adjusted to slope. One may drive for miles in some parts of the Piedmont of the Carolinas, Georgia, and Alabama, where most of the soils are of a moderate to highly erodible character, without seeing a straight row of cotton or corn. Of necessity farmers there resorted to contour cultivation to save their soils, and all rows approach the horizontal without regard to the undulations of slope in the field.

Row crops on all sloping lands in the Piedmont should be grown on the contour. It is simple farm practice, and saves labor, soil, and water.

Owing to the irregularities of slope very few rows may be laid out exactly on the contour. It is better, from the standpoint of erosion control, to lay out in the upper part of the terrace interval those rows that do follow the contour most faithfully, using the terrace as the contour line. Under this arrangement the rows that are farthest away from the channel of the terrace below retain the most water. This arrangement of rows serves to impede the flow of water in the upper part of the terrace interval, which is the part most subject to erosion.

Only when swiftly moving does water have the power to carry large particles of soil. When the speed of flow is slowed, much of the soil load is dropped. The primary purpose, therefore, of every measure of soil defense against erosion is to slow down the speed of running water and force it to drop its soil load. To a degree, contour cultivation does this. Likewise, terracing accomplishes this result by forming a channel in which the water is caused to flow slowly from the field through protected outlets.

One of the newer methods of checking the flow of water, now being employed often as a companion measure with contour cultivation and terracing, is strip cropping. Strip cropping for erosion control consists in seeding the usual farm crops adapted to a locality in long bands, or strips, laid out as nearly as possible on the contour and arranged so that adjacent strips—the strips for cultivated crops sandwiched between strips for thick-growing or broadcast crops—are not plowed at the same time. Under this strip arrangement, water, as it flows down a slope freshly plowed for corn or cotton, encounters a strip of grain or hay crop which, owing to its close-growing nature, checks the flow of water, spreads it, and filters from it its load of soil (fig. 21). Most erosion occurs when the ground is bare, as at seeding time, usually a rainy season. For this reason crops for adjacent strips are chosen from among those having different seeding dates

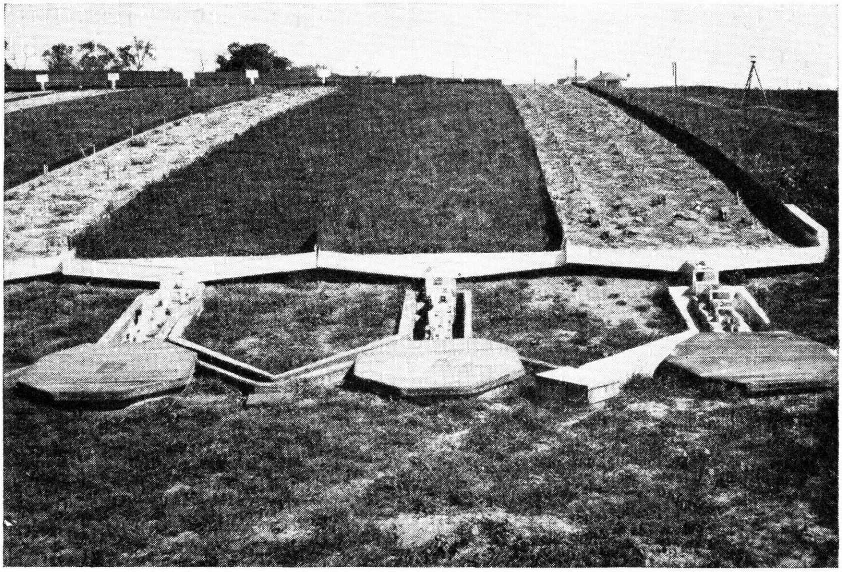

FIGURE 20.—*The erosion-resisting qualities of crops are carefully measured at erosion experiment stations. In the Piedmont, land planted to cotton invariably proves least resistant to soil washing.*

On an erodible slope this practice will do much to save soil, especially should heavy rains come before a crop is firmly established. The practice is also helpful throughout the year, because heavier rains usually cause some erosion, often severe erosion, during all stages of growth of cultivated crops.

There are a number of thick-growing crops adapted to the Piedmont that may be planted in strips with cotton and corn. The most promising of these are sorghum, the small grains, clovers, lespedeza, grass, and vetch. One of the most valuable, both as soil-saver and forage crop, is lespedeza. Another, a mixture of sorghum and soybeans or cowpeas, is gaining favor. If this mixture is cut for hay, and the stubble is left in the field, it offers effective protection against the erosive winter and spring rains.

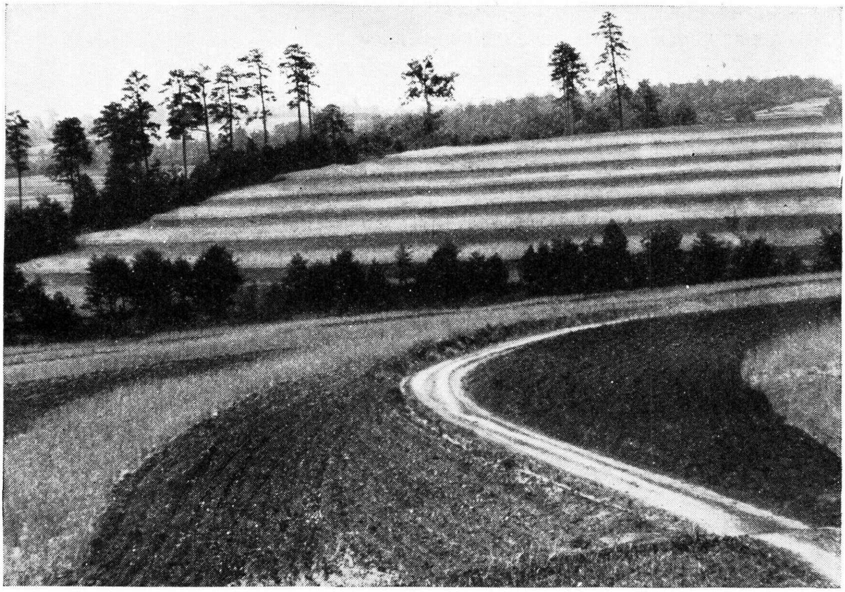

FIGURE 21.—*When a field is strip cropped, water, as it flows down a slope freshly plowed for cotton or corn, encounters a strip of grain or hay crop which, owing to its close-growing nature, checks the flow of water, spreads it, and filters from it its load of soil.*

Strip cropping is a simple and natural procedure on terraced lands. Terraces form natural boundary lines, and strips may be laid on the contour following the terraces in a field. Several methods of adjusting the strips to the terraces are on trial on the demonstration areas of the Service. One method is to extend the strip from the top of one terrace to the top of the adjacent terrace. A second method, now favored over the first is to straddle the terrace, beginning the strip in the terrace interval and extending it over the terrace into the next terrace interval. With this method only

half of the terrace interval is planted to a row crop each season. The other half of each interval is protected from soil washing by close-growing vegetation. Another advantage of the second method lies in avoiding "point" rows in the strips planted to cultivated crops. Since terraces follow the contour of the slope, and therefore are not always parallel, the strips are of varying widths. To avoid point rows one may seed the area of irregular width to a close-growing crop; the area of regular width to a row crop.

When gentle slopes are terraced, the terraces are spaced at rather wide intervals. In order to reduce the length of unprotected slope between terraces on such gentle slopes, strips of a close-growing crop are sometimes planted in the middle of the terrace interval, and row crops on each side of the strip. The strip of close-growing crop is usually variable in width, to take up all or a part of the point rows. This system is earning particular favor where it is necessary to have a large part of the field in row crops.

Although throughout the Piedmont terracing and strip cropping are companion measures of defense, especially on the more erodible soils and slopes, either measure may, in some instances, suffice of itself. Strip cropping is a practical measure, cheap, and easy to apply to a field.

A modified form of strip cropping known as field stripping is used in some parts of the Piedmont, but seldom on terraced lands. The field is divided into straight parallel strips laid out crosswise of the slope. Unless the slopes are uniform, this system permits run-off water to concentrate in low areas, and unless these low areas are protected by a permanent sod, gullies may form. For most of the Piedmont, strip planting strictly on the contour is the safer method.

Best results from strip cropping may be expected from rotating crops from strip to strip. Rotating strips gives double protection. Soil is restrained from washing not only by the thick-growing crop in the strips but also by the erosion-reducing effect of the rotation itself.

Some Piedmont farmers plant permanent strips, usually about one drill's width, to trees, vines, briers, or grass on parts of slopes especially susceptible to erosion. Planting of permanent strips results in the formation, in time, of bench terraces.

CLOSE-GROWING CROPS IN THE ROTATION

It is possible to effect complete control of erosion by use cf vegetative measures alone. This is nature's way, a study of any well-forested hillside or mountainside will show. Soil losses on the steepest slopes of the well-forested Blue Ridge Mountains are not nearly as great as those on nearly level areas in the Piedmont planted to cotton and corn.

It is also possible, fortunately, to effect erosion control on cleared areas by use of vegetative measures, even on the steeper Piedmont slopes if they are not planted to row crops. Slopes covered with sod, even when steep, are free, or nearly free, from accelerated erosion. Even on most cultivated moderate slopes erosion may be held under control by planting annual crops such as the small grains in the fall and close-growing feed crops in the summer (fig. 22). But on slopes of any appreciable degree it is not possible to control erosion when cotton, corn, tobacco, or other row crops are grown over long slopes.

One of the weakest points in the whole program of southern agriculture is the lack of a definite rotation system. Farmers of the South have not

FIGURE 22.—*Close-growing and green-manuring crops in the rotation add organic matter to the soil, which increases its power to retain moisture and decreases soil losses.*

learned, as a group, to rotate crops systematically in cultivated fields. Even when individuals have devised proper rotations they have often used them without considering sufficiently well the slope of the land. Rotations in which cotton occupies the land 1 year in 3, and corn another year of the 3, have been used far too generally on all types of soils and on all slopes.

Many instances of the most severe erosion in the Piedmont date from the period when high prices for cotton pushed this crop onto slopes much too steep for row-crop cultivation. Cotton offers less resistance to soil washing than any crop grown in the Piedmont. Someone has said, with some exaggeration, that cotton plants are hardly more effective in holding the

soil than so many walking sticks thrust into the ground. And were it not for the protection provided the soil by the weeds that appear in corn after it is laid by, this crop would offer little more protection than cotton.

When it is considered that these two row crops occupy most of the cultivated fields in the southern Piedmont most of the time, their inability to hold the soil explains easily the eroded condition of the land. Cotton in the Alabama piedmont occupies approximately half of the cultivated land, and corn is grown on almost 40 percent of it. Even as far to the north as the piedmont of southern North Carolina, fully three-quarters of the cultivated fields are devoted to the culture of these two crops.

Crops have been divided roughly into two general groups: Erosion-inducing crops and soil-holding crops. The important row crops of the Piedmont—cotton, corn, and tobacco—fall in this first grouping. Crops that offer effective resistance to erosion are the small grains, Austrian field peas, vetch, crimson clover, lespedeza, cowpeas, sorghum, Sudan grass, close-drilled or broadcast soybeans, pasture grasses, alfalfa, and other hay crops.

The erosion-resisting qualtities of crops have been observed on the demonstration projects and carefully measured by the experiment stations of the States and the Soil Conservation Service (fig. 20). Invariably in the Piedmont, cotton proves to be the crop least able to resist soil washing.

In tests near Spartanburg, directed by the South Carolina Experiment Station, plots bare of vegetation lost more than 28 tons of soil an acre and a third of the rainfall, during a 4-month period in the growing season of 1935. An adjoining plot planted to cotton lost soil at the rate of 18 tons an acre, although the cotton plants held the water run-off to 18 percent. The fibrous roots of corn on a third plot held the soil better; less than 7 tons of soil was lost an acre, although quite as much water escaped. The plots planted to lespedeza and Bermuda grass yielded amazing records; the lespedeza plot lost approximately 1 ton of soil an acre, and less than 11 percent of the rainfall; Bermuda grass held all but one-eighth of a ton of soil and 1 percent of the rainfall. These figures are averages from four series of plots on different slopes.

In another test, on a 9-percent slope at the Central Piedmont Erosion Control Experiment Station at Statesville, N. C., 36 inches of rainfall removed 213 times more soil from a cotton plot than from a Bermuda grass plot.

At the same station the average rates of erosion from one of the principal soil types of the southern Piedmont—Cecil sandy clay loam—on a 10-percent slope have proved rapid enough to remove the entire depth of topsoil (about 7 inches) in the following periods: when cotton is grown continuously, approximately 75 years; when crops are grown in a 4-year rotation of cotton, corn, wheat, and lespedeza, 170 years; when in mixed grass,

2,000 years; and from bare, fallow land, 19 years. The soil loss from virgin woods occurs so slowly that soil undoubtedly builds up from beneath as rapidly as it is removed from the surface. The immediate run-off of water accompanying these soil losses was recorded as follows: from land in continuous cotton, 8.8 percent of the total precipitation of 45 inches; from land cropped in rotation, 8.1 percent; from land in mixed grass, 3.9 percent; from land lying fallow, 30.1 percent; and from woodland, 1.3 percent when burned and 0.16 percent when not burned.

Further analysis of the effects of the 4-year rotation at the Statesville station shows that during the year (Jan. 1 to Dec. 31, 1934) when cotton was grown on one of the four fields in rotation, 7.8 tons of soil were lost, while the plot in continuous cotton lost 15.6 tons of soil, or just twice as much. Credit for the difference goes to lespedeza, the crop that preceded the cotton in the rotation. From the first of the year until the land was prepared for cotton planting the lespedeza held the soil in the rotation plot from washing, while the soil of the continuous-cotton plot was practically without protection. (In addition, the organic matter incorporated in the soil by plowing under the lespedeza not only materially increased the yield of cotton but rendered the soil more absorbent and resistant to washing.) In the following year, when corn succeeded the cotton, the soil was without the protection of lespedeza during the winter months, and acre losses rose to 13.6 tons. Wheat followed corn, and erosion losses declined to 6.6 tons. In the fourth year of the rotation lespedeza occupied the land and held soil losses to less than 1 ton an acre. In the 4-year period the plots planted continuously to cotton lost 62 tons of soil an acre and the plots in rotation lost 27 tons, a clear margin of 35 tons in favor of the rotation.

CONTOUR FURROWING IN PASTURES

More than a hundred years ago Thomas Jefferson learned that contour plowing conserved water, and that every furrow acts as a reservoir to receive and retain the waters, all of which go to the benefit of the growing plant instead of running off into streams. But only recently have we learned to adapt this principle to pastures. Contour furrowing in pastures is something new and extremely practical. It is meeting with favor in the bluegrass pastures of the Virginia piedmont and in the Bermuda grass pastures of South Carolina and Georgia, more as a measure to conserve water and check run-off than as a measure intended directly to control erosion. The furrows are made by an ordinary two-horse turning plow, and they are turned on the exact contour of the land, as near to dead level as it is possible to run them. Contour furrows catch the rain and retain it until it has time to percolate into the ground. Thus a system of contour furrows in pasture checks the run-off of water, conserves it, and directs it to the grass roots (fig. 23).

FIGURE 23.—*Contour furrows in pastures hold rain water until it percolates into the ground. A system of contour furrows conserves moisture and curbs erosion.*

Frequently before a pasture field may be effectively contour-furrowed it is necessary to heal erosion-scoured spots and small gullies. On the demonstrations of the Soil Conservation Service such areas are plowed, smoothed, fertilized and limed, and seeded. The young grass is protected from overgrazing by a covering of brush.

Soil Defense in the Piedmont

Healing Land "Cancers"

NATURE abhors a gully. Left to her own devices she will take care of such scars on the land, providing a blanket of vegetation to bind the soil and protect it from further washing. But cultivation interferes with nature's work and prevents her from applying a poultice of vegetation to the wound. As a result gullies grow, gnawing their way farther and farther into cultivated fields, sending out "fingers" and laying waste huge areas of land (fig. 24).

Once a field is gutted and gashed by gullies, and abandoned, nature must work hundreds of years to restore it to a semblance of its original condition (figs. 25 and 26). In the Piedmont nature begins her work of reclamation by covering the gullied area with broomsedge, briers, and weeds. Gradually, such growth is succeeded by sassafras, persimmon, sumac, and native pine. After the pines are established and thicken, the eroded area is protected from further washing, and in time the slow process of soil rebuilding begins, proceeding at a rate, let us say, of 1 inch in 600 years. Thus lands that have gullied or sheet-washed to the lower strata of subsoil are lost to further cultivation; to be of future value they must be coaxed into growing forest trees. Only vegetation, given time, will heal these "cancers" of the soil.

Parts of the Piedmont are dissected by millions of gullies, large and small. Such a condition requires corrective, as well as preventive, measures. Many fields may be saved for continued cultivation by taking prompt action against incipient gullies as they appear.

One method of checking gullying in cultivated fields, the use of the sod bag or grass dam, has proved universally successful. Simple to build and inexpensive, grass dams have effaced numerous gullies from large fields. Old fertilizer sacks are filled with grass roots and soil, or with grass seed and soil, and laid across washed places in a field. The sack in

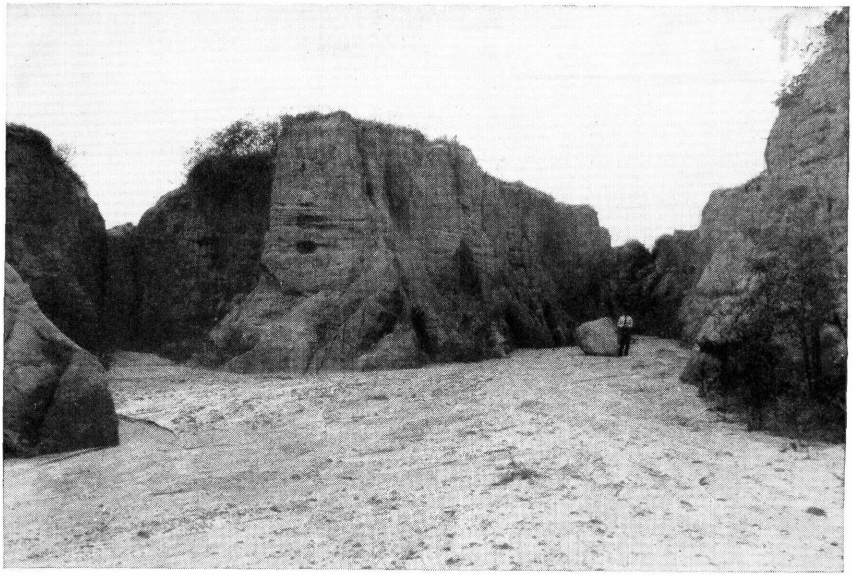

FIGURE 24.—*Gullies grow, gnawing their way farther and farther into cultivated fields, sending out fingers and laying waste huge areas of land.*

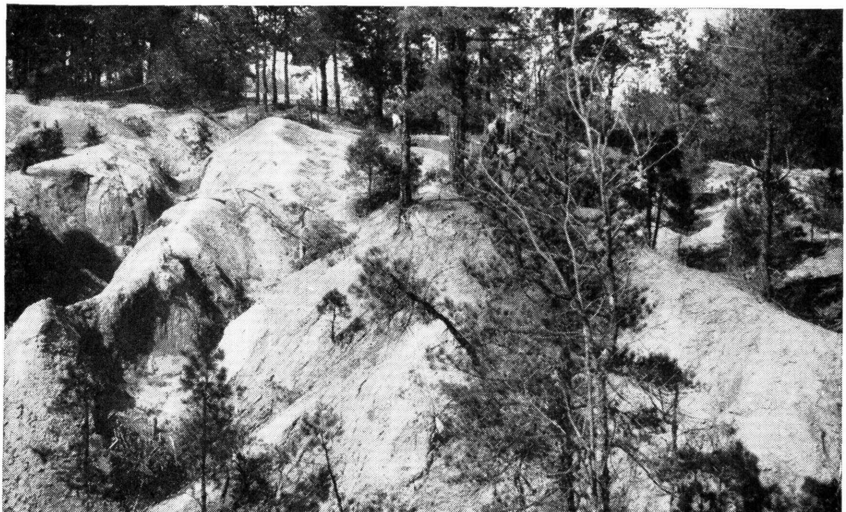

FIGURE 25.—*Nature must work hundreds of years to restore land such as this to a semblance of its original condition.*

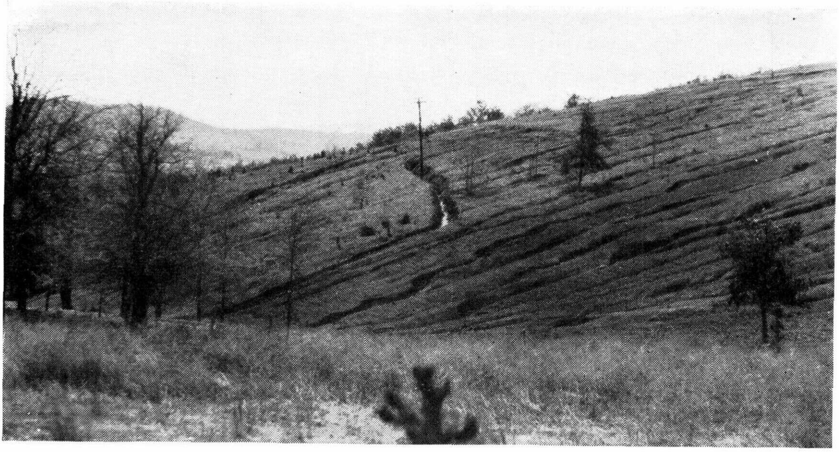

FIGURE 26.—*Severe erosion in the Piedmont dates from the time row crops were planted on hillsides too steep for clean cultivation.*

the center of the gully is set into the ground, half buried, and placed so as to lie below those placed along the slopes of the wash; this precaution insures concentration of the water at the center of the dam and avoids washing around the ends. The plan calls for a succession of these dams the length of the wash. The grass grows through the rotting bags, takes hold, and quickly establishes a stabilized soil condition; and after a while the gully fills as the grass collects the soil washed into it.

A second method is to convert small gullies forming in cultivated fields into grass waterways. Water is first diverted from the head of the gully by means of a ditch; the gully sides then are smoothed by plowing, partially filling the wound, and the area is seeded to a mixture of grasses, or a mixture of perennial legumes and grasses, suited to the soil and locality. In cultivating the field thereafter, the plows and cultivators are lifted as they pass over the treated area. In time the gully will fill, and the area may again be cultivated.

When large gullies threaten to eat their way farther into cultivated fields, considerable preparation is sometimes required to fit such a gullied area for its vegetative cover. The gully is partly filled by plowing round it, throwing furrows of better soil to the bottom where the vegetation must be established. In some instance the sides are graded by a bulldozer—a huge blade pushed by a tractor—or by blasting. Frequently a diversion ditch or embankment is prepared, after the manner of constructing a field terrace, to carry the water away from the gully head until revegetation is complete; then the water may be turned back.

Temporary dams are sometimes constructed to serve a double purpose: to collect soil in which vegetation can gain a foothold and to prevent

further washing until such time as the vegetation gains over erosion. The kind used is determined by the size of the gully and the materials at hand for constructing dams. For the smaller gullies simple brush or loose rock dams are adequate; for the larger ones structures of wire and posts, rocks, or of logs are necessary. Dams may be made of living plant materials. Willow trees, coralberries, and similar trees and shrubs planted thickly across a gully, hold soil as well as temporary dams.

Fortunately for the Piedmont there is a wide variety of native vegetation suitable for gully-control work—grasses, perennial legumes, vines, shrubs, and trees. The most promising of the grasses are Bermuda, dallis, and, farther north, bluegrass, and mixtures of various sorts. Kudzu and honeysuckle have proved superior to other vines (fig. 27). Of the trees the black locust and the native pines offer most promise (fig. 28). Wild plum, blackberry, and other shrubs frequently can be used to good advantage. Of the perennial legumes, kudzu and *Lespedeza sericea* have gained most favor.

Success depends on establishing vegetative cover as quickly as possible. The Soil Conservation Service frequently seeds actively eroding gullies to annual plants to check further washing until the perennial gully plants are rooted. Crops used for this purpose vary with the season: Small grains in the fall and winter, lespedeza in the spring, and Sudan grass or sorghum in the summer.

FIGURE 27.—*A cover of luxuriant vegetation stops gullying. Within 3 years kudzu spreads like a net over a gullied area, binding the soil.*

In planting permanent gully plants, care is taken to cover the channel of the gully with a thick-growing grass. Trees are not helpful in the channel of most gullies, especially of the straight-walled, undercutting type, for they divert water toward the sides, causing increased cutting of the banks. On sloped gully banks Bermuda grass sod is often placed in contour bands approximately 2 feet wide and spaced about 8 feet apart; similar sod bands are set across the channel. When such plants as black locust, native pine, and honeysuckle are planted in gullies they are set at 3-foot intervals, the honeysuckle over the entire area and the locust or pine on the banks. Honeysuckle plantings are usually confined to open areas where

FIGURE 28.—*Millions of vines, shrubs, and trees are required for a soil-conservation program. In this corner of a nursery, planted and tended by CCC boys, are beds of walnut and pine.*

no trees are planted; honeysuckle harbors mice and other rodents which damage the young trees.

Of the many plants suitable for gully work in the southern Piedmont kudzu appears to offer the most promise (fig. 27). Kudzu is an excellent soil-binding plant (it literally ropes land down); it yields a forage that livestock thrive on, and, properly managed may be grazed successfully. A legume, kudzu compares in feed value to alfalfa. In the southern Piedmont, which is perennially in need of good forage, kudzu is used generously on Soil Conservation Service demonstration areas, not only to stabilize an occasional gully but to reclaim large eroded areas that have become

too rough for further cultivation. Fields as large as 30 or 40 acres have been planted to this legume on farms under cooperative working agreement with the Service. Kudzu is most commonly propagated from crowns 2 years old or older or from rolls of vine. Before the crowns are set, in late winter or early spring, series of simple brush dams are placed in gullies in a field. Behind these dams silt collects, and in these silt deposits the crowns are set. The field is cultivated for 2 years to enable the runners to take hold in the soil. Within 3 years the kudzu will have spread over the field; the crowns throw out runners which in a single season may attain a length of 35 feet.

Honeysuckle is another vine which, although it has little or no feed value, is an effective gully control plant. It is invaluable north of the effective range of kudzu. Honeysuckle grows vigorously behind temporary brush dams in gullies and on gully banks if a shovelful of good soil is placed under the plant when it is set.

Etching the Story on the Land

MOST OF THE MEASURES of soil husbandry thus far described have proved themselves through the years. Terracing and contour cultivation, in particular, have withstood the tests of time, and no one questions their worth when properly employed. Colleges of agriculture, the extension services and experiment stations of the South for years have stressed the need for improved crop rotations, urging their use to conserve and build soil. On the other hand, strip cropping is an innovation almost unknown outside the Service demonstration areas, and gullies, as a rule, are permitted to grow unheeded.

Let us assume that a farmer is duly alarmed about his soil losses and wants to take steps to avoid further depletion of his soil capital. It is hardly an exaggeration to say that, up to a year or so ago, such a farmer could find nowhere in the Piedmont a single farm on which all of the modern measures of soil defense were in use. He could go to one farm to inspect contour tillage and terracing work; to another to see strip cropping; to still another to study a soil-building rotation; to another to absorb a few pointers on gully-control work. But it is unlikely, even if he had searched, that he would have found a farm similar to his own where terrace water was carefully and safely handled. In short, it was a long, painstaking task for a farmer to find out, through his sense of sight, exactly how to go about adjusting his farm operations to control erosion.

And so, by the time the Soil Conservation Service was created in 1933, it was apparent that the greatest and most immediate need in a national program of soil saving was a series of demonstrations, on a convincing scale, of the various proved erosion-control practices.

The Service immediately upon its creation therefore was assigned the task of providing demonstrations of this kind. Areas typical of agricultural regions were chosen. Throughout the Piedmont these demonstra-

tions are spaced rather closely, usually less than 75 miles apart. From the map (fig. 5) it may be seen that most farmers live within little more than an hour or two, by car, of a demonstration project.

Whole watersheds were selected for demonstration areas, embracing from 300 to 1,000 farms and from 25,000 to 150,000 acres of land. Once a project area was selected the farms of all the cooperating farmers of the watershed were surveyed to determine the degree of erosion, the use to which farmers were putting their land, the slope of the fields, and the physical and chemical characteristics of the soil—in other words, a careful inventory was made of the various kinds of land that go to make up a farm and the various uses made of these different parcels of land.

The results of these surveys are the basis for planning an erosion-control program for an area. After the plan is drawn it is presented to the farmers, along with an invitation to take part in the program. Those who decide to participate sign written cooperating agreements to follow certain erosion-control practices for a period of 5 years. The Service, on its part, agrees to render certain technical and material assistance in carrying out the program on the farm under agreement.

Before an erosion-control program is finally completed for a particular farm, the farmer and the specialists of the Service walk over it, field by field, and talk things over. Together they plan a 5-year farm program. They determine how best to meet cash-crop and forage requirements, and work out a cropping plan. They plan rotations and fit these rotations to the various fields according to soil type, slopes, and susceptibility to erosion. Cotton and corn, for example, are withdrawn, on the plan, from the steeper, more erodible slopes, and rotations containing soil-binding crops are assigned to them. On the more moderate slopes, they plan, for example, to plant cotton and corn in strips between other strips of soil-binding crops such as the small grains and legumes. They designate which fields are to be terraced and where the drainage waterways shall be located. They decide what to do with certain badly eroded fields, whether to retire them to pasture or to trees, and if so, what plants to use. They relocate fences in order to reshape fields for terracing and strip cropping. When they have finished, the farm program for the next 5 years is planned to make full use of all known practical devices that husband soil.

More than 50 Civilian Conservation Corps camps have been placed at the disposal of the Soil Conservation Service in the Piedmont. Without the proffered assistance of the CCC boys the demonstration program could not easily have been extended on such a useful and convincing scale. An undertaking that involves the demonstration of a wide variety of erosion-control practices on thousands of farms in the Piedmont entails an enormous amount of labor. CCC boys and relief laborers provide this (fig. 29). The boys of the Civilian Conservation Corps go into the fields and woods

to collect seeds of promising soil-conserving plants for nursery plantings; cure, store, and plant the seeds in beds; grow vines, shrubs, and seedling trees and plant them on wasting fields and in growing gullies; dig diversion ditches; slope gully banks, protect gullies temporarily from washing by erecting dams, and otherwise fit them to receive the products of the nursery. They dig terrace-outlet channels and protect them with baffles or adaptable grasses; and build loose rock, wood, or masonry structures and plant vegetation to protect terrace outlets.

The farmer, on his part, furnishes labor, builds and maintains terraces, provides teams and materials, and plants his crops according to specifica-

FIGURE 29.—*Much of the labor required for an erosion-control program is supplied by CCC boys.*

tions contained in the cooperative farmer-service agreement. The Service provides a part of the seed, fertilizer, or lime when necessity requires expenditures for such items. The Service also lends terracing equipment to the farmer and provides, frequently from relief rolls, an experienced tractor operator to build a part of the terraces.

VIRGINIA'S BANISTER RIVER DEMONSTRATION

The Banister River meanders through the heart of Pittsylvania County, Va., coursing through a narrow sand-choked valley on its way to the Dan River. Flowing over sand flats, it rises in flood over narrow bottoms after each heavy rain, only to subside to its sluggish course within a few

hours. It carries a great amount of silt when its waters are high—soil from the eroding fields on the hillsides that rise above the valley. Much of this silt comes to rest on the bottoms, or behind dams built across the Dan. Back from the sandy high frontal banks of the river, much of the land is poorly drained, and swampy much of the year, the result of overflows and imperfect drainage outlets. Little of this bottom land is cropped.

Not much of this silt is the wash from gullies. Pittsylvania County, for a Piedmont county, is not severely gullied; less than 1 percent of the county is cut by more than three gullies an acre, and only 1 acre in 9 exhibits as many as one to three gullies. Most of this silt consists of surface and subsoil material washed from the slopes by the processes of sheet erosion. A survey of 45 typical farms in the county revealed that 59 percent of the area had lost, by sheet erosion, from 25 to 75 percent of its original topsoil. Even more severe than this is the eroded condition of 15 percent of the surveyed area, which has lost three-quarters to all of the original topsoil. The rest of the area has lost varying amounts up to a quarter of the original topsoil.

The Banister River demonstration area is located centrally within Pittsylvania County, and its topography and agriculture are typically Piedmont. The topography ranges from almost level land on the interstream uplands, the plateau proper, to very steep slopes along drainageways. It is in the heart of the flue-cured tobacco section of Virginia.

Until the area was chosen for demonstration purposes by the Service not much was done to curb erosion losses. Although farmers in general prided themselves upon the straightness of their rows the practice of contour cultivation was coming into favor; approximately 8 percent of the fields were tilled on the contour. Strip cropping and terracing, however, were not practiced, and scarcely more than 10 percent of the area was planted in soil-saving rotations.

Because land suitable for growing flue-cured tobacco requires special cropping treatment, the Service introduced two general types of rotations on the tobacco farms in the district, one for tobacco land and one for the general-farming area. Flue-cured tobacco rotations may contain no legumes, for the residue of nitrogen left in the soil by this group of plants has a harmful effect on the quality of the product. In the past it has been a common practice to single-crop tobacco fields, and, after 10 or 15 years, when the land has become eroded and exhausted, to clear a new patch. Three rotations are used on the tobacco land: A 1-year rotation of tobacco each year, followed in the fall by rye to be plowed under in the spring; a 2-year rotation of tobacco, and a small grain succeeded by weeds or rye; and a 3-year rotation of tobacco, followed by small grain and then redtop. Sloping tobacco lands are contour-tilled and terraced.

Two rotations are used on the general farming land, one for worn land and another for the better soils. On worn land corn is followed by a small grain in the second year and lespedeza in the third. This rotation may be extended to 4 years by permitting the lespedeza to stand a second year. On better land corn is grown with cowpeas the first year, succeeded by a small grain the second year and by clover and grass the third and fourth years.

In the area there are some 35 recognized soil types falling into 20 soil series. These soil types are divided into six groups according to their ability to resist soil washing. Control practices employed on a particular field depend on the slope of the field and the erodibility of the soil. Soils of the first group are resistant to erosion, and on slopes up to 4 percent contour tillage is usually adequate for curbing soil losses by erosion. Slopes greater than 4 percent are terraced, the terraces spaced widely apart. Cultivated slopes above 8 percent are protected at least part of the time by close-growing crops and the system of terraces is buttressed by the practice of strip cropping.

Soils of the second group are fairly deep. They have sandy surface soils underlain by compact subsoils and wash more easily than soils in the first group. Contour cultivation on all slopes is essential for adequate control of erosion. Planting crops in strips and rotating the strips serves to hold the soil on slopes up to 7 percent, steeper slopes are terraced also. During some part of the year a close-growing crop appears in the rotation.

If neglected, soils in the third group erode fairly rapidly. They are sandy loams. An erosion-control program for these soils requires first of all a good rotation, and terracing and strip cropping to enhance their water-holding capacity. Turning under green-manure crops improves water absorption and reduces run-off. On slopes up to 5 percent crops are planted on the contour in strips; the strips are rotated and fields are terraced. On slopes from 5 to 12 percent sod crops and winter-growing crops are given a place in the rotation.

Soils of the fourth group are extremely susceptible to erosion, and as a rule much of the surface soil has already been lost. Subsoils are compact, heavy, and impervious. To preserve the little topsoil that remains, contour cultivation, strip cropping in rotation, and terracing are necessary, and the growing of green-manure crops is highly desirable. Steeper slopes are covered with close-growing crops during the winter and through much of the summer growing season. Cultivated strips are alternated with strips of close-growing crops and no slopes above 10 percent are planted to row crops.

Soils in the fifth and sixth groups require for their protection every known erosion-control measure recommended for the region. Terraces are spaced more frequently, strip cropping and contour tillage are practiced, and

fairly large proportions of the close-growing crops find a place in the rotations. No row crops are planted on slopes above 10 percent. Much of this land is retired to permanent vegetative cover.

Terrace water is drained into woods, stabilized natural drainageways, or streams. Meadow strips are often used in fields that have a slope of as much as 5 percent to carry water from terrace outlets. These strips are 40 to 60 feet wide, or more, their width depending on the volume of terrace water that must be cared for, and they follow a natural draw or swale in the field. Some are a quarter to a half mile long and comprise an area of several acres. They are as level from side to side as it is possible to make them. Limed and fertilized and seeded with a mixture of grasses, lespedezas, and clovers they produce excellent forage. On steeper slopes terrace-outlet channels are of the broad, shallow-ditch type reinforced with spreader dams of concrete or stone.

Most pastures are on steeper slopes, and as a rule are too thinly sodded to curb erosion. For the most part they are scoured with shallow gullies. These are smoothed, limed, fertilized, and seeded with a mixture of redtop, orchard grass, Kentucky bluegrass, and common and Korean lespedezas; they are protected from overgrazing by a covering of brush. Then the pasture is contour furrowed, not only to check further gullying but to conserve water.

Permanent structures are constructed in gullies only when it is not possible to divert water or when terrace water must be emptied into them. When necessary, temporary structures of wire and posts, rock or brush are built across a gully floor to prevent further cutting while vegetation is getting its start. Banks of the larger gullies are sloped and planted to shrubs, vines, or trees, and the gully floors are seeded with a mixture of grasses, clovers, and lespedezas.

NORTH CAROLINA'S DEEP RIVER DEMONSTRATION

Embracing 216 square miles, the Deep River demonstration area lies in those portions of Forsyth, Guilford, and Randolph Counties within the watershed of the Deep River and its tributaries, in Piedmont North Carolina. The agriculture of the district is diversified. Almost half the farmers grow bright-leaf tobacco, about 5 acres a farm. Some livestock and poultry are raised on practically all farms. The southern part of the district dips into the Cotton Belt.

Damage from sheet erosion is general, and there is some gullying, although this form of erosion is not so glaringly evident as in much of the Piedmont. Approximately half of the topsoil has been lost from the cultivated fields, and a large portion of the land now in pine was abandoned because of severe erosion. Almost a third of the district is woodland. In 1934 a survey revealed that fully half of the bottom lands were

buried under erosional debris. After the floods in the winter and spring of 1936 this estimate was revised upward to 75 percent.

Prior to 1934 few farmers followed a system of cropping that conserved or improved the soil. Some of the soil-building and erosion-resisting crops were grown, but not as a part of a coordinated program to curb soil losses. Only a few farmers planted crops in definite rotation. Clean-tilled crops were grown on many of the steeper hillsides, and only a few fields were cultivated on the contour. The practice of strip cropping was unknown.

Crop yields were low, too low in many instances to be profitable. Corn yields averaged about 20 bushels an acre, and wheat yields 12 bushels an acre, on fertilized land.

By the spring of 1936 approximately 80 percent of the cooperating farmers in the district had established rotation systems. Those engaged in general farming had adapted one or more of the following rotations to their fields:

A 4-year rotation of corn followed by a small grain in the fall of the first year; cowpeas or soybeans followed by a small grain in the fall of the second year; lespedeza, or clover, or clover mixture, or hay mixture for the third year seeded in the small grain the previous fall; and lespedeza, or clover mixture, etc., the fourth year.

A 3-year rotation of corn, followed by a small grain in the fall; lespedeza, or clover, or clover mixture, or hay mixture seeded in the small grain for the second year; and lespedeza, clover mixture, etc., the third year.

A 2-year rotation of corn and soybeans, followed by small grains in the first year; lespedeza, crimson clover, or vetch the second year.

The rotations established for the cotton farms are:

A 4-year rotation of cotton, followed by vetch the first year; corn or cotton, followed by a small grain the second year; lespedeza, or clover, or clover mixture, or hay mixture seeded in the small grain for the third year; and lespedeza, or clover, or clover mixture, or hay mixture the fourth year.

A 3-year rotation of cotton, followed by a small grain in the fall; lespedeza, or clover, or clover mixture, or hay mixture seeded in the small grain the second year; and lespedeza, or clover, etc., the third year.

A 2-year rotation of cotton, followed by a small grain in the fall, and lespedeza the second year.

For tobacco farms there are, likewise, three rotation systems:

A 4-year rotation of tobacco, followed by rye in the fall of the first year; tobacco, followed by rye and redtop [2] seeded in the fall in the second year

[2] For reasons which are not fully understood, the tobacco crop following redtop, timothy, or other grasses usually is a failure on some soils, while on other soils satisfactory results are obtained. Although this problem has been extensively studied, it is not possible at this time to predict the results to be expected from a given soil type. Consequently, the inclusion of redtop in the rotation may be recommended only if there is sufficient background of local practical experience to indicate that satisfactory results will be obtained.

(some seed the redtop in the following spring); and redtop the third and fourth years.

A 3-year rotation of tobacco, followed by rye in the fall, followed by 2 years of redtop. The redtop may be seeded in the rye or early the next spring.

A 2-year rotation of tobacco followed by rye in the fall, and redtop the second year.

The abundance of close-growing crops in these rotations presents a situation suitable for strip cropping. Crops are planted in both broad and narrow strips with or without terraces. All strips are on the contour. Either annual or perennial crops are planted in the narrow strips. Narrow strips used in conjunction with terraces are placed either midway of the terrace interval or from the crest of the terrace across the water channel and above it for several feet. The minimum width is 20 feet. Those intended to stand for several years are planted to alfalfa, clover mixtures, hay mixtures, or lespedeza.

Narrow strips established for only one season are planted either to mixtures of cowpeas and Sudan grass or soybeans and Sudan grass. These strips are irregular in width so that short rows are eliminated in the clean-tilled crops.

The width of the terrace interval determines the widths of the broad strips. Crops on the broad strips are planted in rotation. Beginning midway of one terrace interval, the strip extends over the terrace to approximately midway of the next terrace interval. Where there are no terraces, the broad strips are placed astride contour lines.

Soils in the district vary widely in character and texture. There are extensive bodies of light sandy surface soils, tracts of sandy loams, and rather large areas of red clay soils. There are 27 soil types in all, falling into 12 soil series. The use to which the land is put and erosion-control practices applied to a field are limited by the soil type. On such variable soils as Helena, Wilkes, Orange, and Iredell, for example, strip cropping in rotation, narrow strips on contour, and contour cultivation are relied upon. These soils do not respond favorably to terracing. All slopes of more than 10 percent are withdrawn from cultivation and seeded to pasture or planted to trees. On the other hand, such soils as the Mecklenburg, Cecil, Davidson, and Georgeville are terraced, strip cropped in rotation, and contour tilled. Slopes up to 12 percent are terraced unless more than 75 percent of the topsoil is gone or the area is gullied. Such areas and steeper slopes are retired from cultivation. Then there are such soils as the Appling, Herndon, and Alamance which, if not studded with rock outcrops, are terraced. The stony and gravelly phases of these soils are highly absorptive and do not require terracing. Strip cropping in rotation and contour cultivation offer sufficient protection.

Proper design, construction, and maintenance of outlets and outlet channels is a major problem. Owing to variations in soil types and scope and the prevalence of natural cover and to other conditions, terrace water is handled differently over the district. To the south, where the fields are smaller, where there are more natural woodland patches and meadows, and soils are less erodible and the slopes less steep, vegetative control of outlets holds most promise. In other sections, especially on the tobacco soils in the northern and central sections of the district where the soils erode more rapidly, slopes are steeper, fields are larger, and there is less natural cover, it is not always possible to control excessive cutting in terrace-outlet channels without resorting to concrete baffles or sodding.

One of the most successful methods of handling terrace water is to turn it into meadow strips, natural meadows or made meadows, in a depression that slopes gently toward a stabilized grade. The soil must be productive and produce good growth.

To establish sod in an outlet channel a seedbed is prepared, the seed is sown, fertilizer is mixed with the topsoil and covered lightly, then the channel is mulched with straw. A few channels have been covered with burlap, securely staked and stapled.

Good pastures are few. Most pastures are woodlands and hillsides too poor to grow a sod thick enough to protect the slope from erosion. To improve these old, worn pastures it is necessary to fertilize and lime the soil so that it will produce and support a good sod. New pastures are also established on steep, erodible land retired from cultivation. Some pastures are contour furrowed.

The Deep River district is one of small fields broken by woodland and hedge rows, an ideal habitat for wildlife. To promote the propagation of wildlife, seed plants that provide both food and cover are generously employed in the erosion-control program. Such plants are set out in gullied areas, in small fields removed from cultivation, in unused corners about the farm, in field borders and elsewhere in places in need of protection from erosion although not satisfactory for crop production.

SOUTH CAROLINA'S SOUTH TIGER RIVER DEMONSTRATION

The South Tiger River demonstration district, a strip of land 4 to 8 miles wide and 35 miles long, lies in the heart of the general cotton-farming section of the South Carolina piedmont. The headwaters of the South Tiger River drain the moderately steep slopes of that part of the Piedmont lying close to the Blue Ridge Mountains, but as the stream winds its way southeastward through its narrow valley, the slopes moderate, and near its mouth the terrain is gently rolling. The demonstration district comprises the whole of the watershed, 1,478 farms and 105,000 acres. Very nearly 40 percent of the area is in woodland, and about 20 percent is classified as idle land.

For years cotton and corn were grown almost exclusively, and the effect of continuous clean cultivation is reflected in the eroded condition of the soil. From one-quarter to three-quarters of the original topsoil is lost from fully 75 percent of the district, and about 15 percent of the fields, the topsoil almost all gone, is netted with shallow gullies. Hardly more than 10 percent of the district retains more than three-quarters of the original surface soil, and much of this, in the bottom lands along the streams, is buried under sand and finer textured materials deposited by flood waters. In part of the district gullies occasionally cut deep through the subsoil down to parent-rock material.

Terracing and contour cultivation have been standard erosion-control practices for a long time in practically all fields, but most of the terraces constructed in the past were too steeply graded, often poorly spaced, and seldom provided with adequate outlets. Crops were not grown in strips until the Service introduced this practice, and few fields were planted in systematic rotation. Winter cover crops were seldom sown, and only a few of the more progressive farmers planted such crops as vetch, rye, and Austrian winter peas. It was the habit generally, in this old Piedmont country, to plant cotton year after year on the best fields.

A preliminary survey at the time the watershed was selected for demonstration revealed a need for a more extensive program of erosion-control measures on practically all open land in the district. The program as it is now being carried forward stresses terracing and the disposal of terrace water, contour cultivation, strip cropping, improved rotations to include close-growing soil-holding crops in the cropping system, contour furrowing in pastures, retirement of certain areas to trees, shrubs, or pasture, and, to a limited extent, gully control.

The Service introduced two rotations: a 3-year strip rotation for slopes of 7 to 10 percent, and a 2-year strip rotation for slopes above 10 percent. One or the other of these rotations is now generally practiced on all cultivated fields under agreement. The 2-year rotation, recommended for the steeper slopes, consists of small grain in the fall, followed by lespedeza and corn. The lespedeza stands through the winter and is turned under for the corn, which follows in the second spring. The 3-year rotation, for slopes up to 10 percent, consists of cotton, small grain followed by lespedeza or summer hay, and corn.

Broad-base terraces are recommended for all cultivated fields sloping from 3 to 14 percent. Under certain conditions slopes of less than 3 percent are terraced, as, for instance, when water from a lesser slope will drain down to a slope of steeper grade unless diverted by terraces.

Terracing and strip cropping are companion practices on all cultivated slopes of 7 percent or more, and on lesser cultivated slopes when the land is gullied and half of the topsoil is lost.

On the steeper cultivated slopes above 10 percent in grade, where a 2-year rotation is used, strips are made one terrace interval wide, the strips straddling the terrace ridge. Strips of small grain, followed by lespedeza, are alternated with strips of corn in which a summer legume is broadcast at the time of the final cultivation. These practices protect all of the slope with a close-growing crop through the winter and early spring, the period when soil losses are most severe under the conditions of clean cultivation which formerly prevailed.

On slopes of less than 10 percent (the slopes in 3-year rotation), the width of the strip of close-growing crop is one-half the width of the interstrip row crop of cotton or corn. The strip of row crop is as wide as two terrace intervals, and the strip of close-growing crop is as wide as one terrace interval. Crops used in the erosion-control strips are the winter small grains—wheat, oats, barley, and rye—and the summer hay crops—cowpeas, soybeans, lespedeza, sorghum, and Sudan grass.

On slopes of 3 to 7 percent that are well protected by terraces, one-third of the field is seeded to a small grain and two-thirds to cotton and corn in rotation.

Many cultivated fields must be retired to permanent sod or to trees and shrubs. Slopes above 14 percent are retired to permanent sod where not more than 75 percent of the original topsoil is lost, and the lesser slopes when more than 75 percent is lost and the land is considerably gullied. Where the slope is greater than 14 percent and 75 percent or more of the topsoil is gone, the land is retired to trees and shrubs. Trees and shrubs are planted also on lesser slopes where gullying is severe or where the supply of woodland products for farm use is inadequate.

The more severely eroded lands are planted to black locust. A little commercial fertilizer is used to stimulate growth. Shortleaf and loblolly pine are planted on the better lands that are retired to trees. Limited plantings of black walnut, ash, poplar, and other hardwoods are made on suitable sites.

About a third of the pasture is bottom land and requires little treatment other than seeding to suitable grasses. Other pastures are on the uplands; they respond well to the moisture-conserving practices of contour furrowing and terracing. Bermuda grass and lespedeza are planted on such areas. A small proportion of the upland pasture, about 5 percent, is retired to trees and shrubs.

GEORGIA'S SANDY CREEK DEMONSTRATION

In Georgia the first Soil Conservation Service demonstration area was established near Athens, in contiguous parts of Jackson, Madison, and Clarke Counties. The district, representative of piedmont Georgia, comprises about 1,000 farms and 104,000 acres and extends over the whole of

the Sandy Creek watershed and a part of the drainage basin of South Fork of Broad River. Slopes and soils are variable, exhibiting practically all types and degrees of water erosion. The rate of erosion is rapid on the steeper slopes. In some instances soils that 15 or 20 years ago were classified as sandy loams are now sandy clay loams or a patchy association of sandy loam, sandy clay loam, and clay loam, so quickly is erosion transforming their character. Gullies occur over much of the district; many are small and with a little care in plowing and tillage may be filled; a few have grown to several hundred feet in length and to a depth of 40 feet or more. Streams fill rapidly with silt; three times in 20 years a small dam on Sandy Creek was raised in order to maintain a head of water, and behind the Barnett Shoals Dam on Oconee River, nearby, 50 feet of silt accumulated in 25 years. Streams course through narrow valleys, and floods are frequent and destructive, damaging bridges, millponds, crops, and bottom lands. Crops on land adjacent to streams are so frequently destroyed that much of this first-bottom land has been abandoned or is used for pasture or meadow only. One flood in 1935 destroyed five bridges on Sandy Creek.

Before the Agricultural Adjustment Administration induced curtailment of cotton planting, this crop was grown on just half of the cultivated acreage; corn was grown on three-eighths of it, and small grains on the remaining eighth. At the time the district was chosen for a demonstration, in 1934, a third of the cultivated land was in cotton and a third in corn; the rest was in small grains or cover crops or was standing idle. About half of the total area is cropland; the other half is woodland or permanent pasture or is awaiting natural reforestation. Cotton affords most of the cash income. Small amounts of vegetables, poultry, eggs, cream, butter, pork, and wood and lumber are sold. About one farm in four is operated by a resident owner, the others by tenants.

Farmers of piedmont Georgia were actively aware of erosion before the Service established its first demonstration area there. For years they had striven with terraces to check the ravages of unrestrained erosion and had practiced contour tillage diligently but not always successfully. Many of their terraces were of the hillside-ditch type, built sometimes with as much fall as 3 feet in 100. An occasional field was strip cropped, usually by chance. Little thought was given to rotating crops; cotton was generally planted on the best hill land and corn on the second-best hill land and on the bottoms, and wheat or oats followed by a summer hay crop on land that needed resting. A few gullies were plugged with rock or brush or stabilized with honeysuckle. Scoured places in fields sometimes were mulched with corn or cotton stalks. To hold the soil, spring plowing was favored over fall plowing, and a few farmers, to render their soils more absorptive and friable, plowed with a scooter (bull tongue) rather than with a turning plow.

Work on the Sandy Creek project began in 1934. When the transformation of the district into a demonstration is completed in 1939, all sloping cultivated fields will be adequately protected by terraces. The work of building terrace-outlet ditches and protecting them with vegetation and baffle or spreader dams will be finished. All erodible fields will be contour tilled, and 80 percent of the cultivated area will have the additional protection afforded by the practice of strip cropping. About 15 percent of the steeper, more erodible slopes that now are cultivated will be seeded to permanent pasture or planted to forest trees or to kudzu. Fields that formerly were bare through the winter will be protected from beating winter rains by small grain, cover crops, and summer-hay stubble. Many of the upland pasture fields will be protected from washing by contour furrows. Hundreds of gullies will be healing, protected by vegetation.

Cooperative understandings with farmers call for the planting of close-growing crops in the fall on approximately 50 percent of the cultivated land to protect the soil from washing during the winter. Formerly only 12 percent of the land was covered during the winter by vegetation, mainly with wheat and other small grains. Most of the increase in winter cover may be attributed to the introduction of the winter legumes, such as Austrian winter peas and hairy vetch, into the crop rotation, and the rest to the substitution of oats, rye, and barley for corn.

The winter legumes are turned under in the spring, and the land is prepared for corn. The organic matter thus plowed into the soil renders it more porous during the summer and better able to absorb and retain moisture for the corn crop; and the nitrogen added to the soil by the legumes may be expected to improve yields materially.

The treatment accorded each field in the district depends on its slope, its soil, and the needs of the farm. As a rule, slopes under 3 percent on the Sandy Creek district do not erode so seriously that soil cannot be held by contour tillage and strip cropping in rotation. However, soil losses on slopes of the second classification, those of 3- to 7-percent gradient, although usually moderate, sometimes become greatly accelerated; and for most effective control such slopes must be terraced and contour tilled and the longer slopes afforded the additional protection of strip cropping. Some of the shorter slopes of 3- to 7-percent gradient may be effectively protected by a good system of strip cropping, without terraces, where the soils are not unusually erodible, especially when the cultivated and thick-crop strips are alternated in a rotation system.

From the standpoint of effective erosion control it would be well, generally, to eliminate all row crops from slopes above 7 percent, planting them to thick-growing crops; but this is an ideal impossible of practical attainment on a considerable number of Sandy Creek farms. When such

fields retain some of their topsoil and are not too badly broken by gullies, they are terraced, contour tilled, and strip cropped; otherwise they are retired to pasture, to trees, or to kudzu. Row crops are strictly limited to not more than half of the strips in these steeper fields. Slopes above 12 percent are retired from cultivation.

Rotations play a leading part in the erosion-control program for the Sandy Creek district. A number of systems are on trial. The prime purpose of the rotation, so far as erosion control is concerned, is to provide a protective cover of vegetation for the soil as much of the time as possible. When cotton, corn, and small grains are the only crops grown this cover cannot be provided; and it is necessary therefore to introduce other crops into the rotation. Rotation systems for the Sandy Creek district fall into two general groups: Those for the lesser slopes of 3 to 7 percent, and those for the sharper slopes of 7 to 12 percent. Enough close-growing crops are given a place in the first group of rotations to cover the ground at least half of the time. The second group of rotations, designed for use on erodible slopes of 7 to 12 percent, provides a protective cover of close-growing crops three-quarters of the rotation period.

On the Sandy Creek district any one of the following rotations provides a cover of thick-growing vegetation for half of the year, provided the summer hay stubble is left standing until spring: (1) 1-year rotation—cotton or corn followed by winter cover crop; (2) 3-year rotation—corn, cotton, winter grain, followed by summer hay; (3) 4-year rotation—cotton, winter cover crop, corn, winter grain, summer hay, and back to cotton; (4) 5-year rotation—winter legume cover crop, corn, cotton, winter grain, summer hay, cotton, winter legume, corn.

To provide cover of thick-growing crops three-quarters of the time, one of three rotations is employed on slopes of 7 to 12 percent: (1) 2-year rotation—cotton or corn, winter grain, summer hay; (2) 3-year rotation—corn, rye cover crop, cotton, winter grain, summer hay, corn; (3) 4-year rotation—cotton and winter legume, corn, rye cover crop, cotton, winter grain, and summer hay.

The soil-binding crops used in the control strips are the small grains—oats, wheat, and rye—followed by summer hay and cowpeas, sorghum, lespedeza, soybeans, Sudan grass, or brown-top millet. Lespedeza sometimes is used as a permanent meadow strip; to provide a thicker stand the first year annual lespedeza is sowed with the *Lespedeza sericea*. During the fall Austrian winter peas, hairy vetch, crimson clover, and rye are planted in strips for turning under in the spring. Newly constructed terrace ridges are sown to a thick-growing crop until they settle. Afterward the strips are planted between ridges, although some strips are planted straddling terraces. In the final plan the strips are as wide as one, two, or three terrace intervals.

Only gully-control structures of the soil-catching type are employed; they stand about 12 or 18 inches high and are built of wood posts and poultry wire or loose field stones. In the backfill of soil that accumulates between the gully structures Bermuda grass is planted; the gully sides are planted to trees, shrubs, and vines. The temporary structures are expected to last about 3 or 4 years, or until vegetation is vigorously rooted and capable of holding the soil without mechanical aid. The vegetation commonly used in gullies is black locust, or kudzu, Japanese honeysuckle, Bermuda grass, or *Lespedeza sericea*.

Idle land is permitted to revert to native vegetation—broomsedge, lespedeza, and finally trees, principally loblolly pine. If seed trees of native species stand nearby, eroded and abandoned areas naturally acquire a thick stand of trees in from 5 to 15 years; otherwise they must be planted. Upland withdrawn from cultivation for pasture is planted to Bermuda grass; bottom lands to Dallis grass, carpet grass, lespedeza, and white clover.

ALABAMA'S BUCK AND SANDY CREEK DEMONSTRATION

The Buck and Sandy Creek district, comprising some 119,000 acres in Tallapoosa and Chambers Counties, is typical of piedmont Alabama. Its surface is hilly and broken. Streams have worn irregular and deep V-shaped valleys. Fields slope moderately, rising on the average about 8 feet in 100, with extremes up to 20 feet in 100.

The whole of the watershed is severely eroded. Fully 85 percent of the original loamy surface soil, which at one time reached to a depth of 6 to 10 or 12 inches, has washed away, and gullies in cultivated fields are cutting into the exposed subsoil. Bottom lands are buried under 1 to many feet of material washed from the neighboring uplands. Streams are clogged with debris, the water table in the valleys has risen, and the little topsoil that remains uncovered is saturated and for the most part unfit for cropping.

Hardly more than a third of the district is now in cultivation; the rest is woodland, pasture, and gullied land not yet grown to trees. Fully a third of the district has been retired from cultivation. Cotton is the principal crop; just 49 percent of the cultivated land was planted to it at the time the Soil Conservation Service surveyed the district. Corn occupied 40 percent of the land. About 6 acres in 100 were planted to subsistence crops, and less than 4 percent of the cultivated fields were in small grains, less than 2 percent in winter legumes, and less than 3 percent in summer hay. Interplanting of legumes with some of the corn was an accepted practice.

Farmers in the district are anxious about erosion. They believe wholeheartedly in terracing and in contour cultivation, two measures rather generally employed for some years. The terraces, it is true, are narrow

and weak; yet they are the best farmers felt they could build with the inadequate terrace-building equipment at hand. Continuous cropping to cotton and corn was the rule. Not more than 6 percent of the land, all told, was protected by cover crops at any time during the year. Strip cropping was not practiced.

More than 50 inches of rain falls each year, often in heavy downpours, and much of it during the winter months when the soil, under the then-prevailing cropping system, lay unprotected by any sort of vegetative covering. During the summer months cotton and corn, which are inferior soil-holding crops, occupied most of the cultivated land. Obviously, to hold this Alabama piedmont soil from further excessive washing, under these unfavorable erosion-inducing conditions, the farming practices in the district had to be changed, and radically.

When work on the new program began in 1934, farmers readily agreed to change their cropping system and signed agreements to follow, for a period of 5 years, the practices recommended by the Service. The soil-conservation program for the Buck and Sandy Creek district calls for a 2-year crop rotation to replace continuous cropping of cotton and corn; contour cultivation of all fields; building of terraces on all sloping, cultivated fields and on pasture and meadow fields sloping more than 3 percent; strip cropping of all terraced fields; the retiring of some of the land from row crops to meadow, pasture, kudzu, or trees; and the checking of gullying by free use of vegetative methods and simple and inexpensive temporary dams.

The 2-year rotation introduced in the district contains as large an acreage of the small grains as may be used to advantage on the farm and as large an acreage of the winter legumes as the farmer can successfully manage. Close-growing winter strips of small grains and winter legumes cover approximately one-half of the farm area during the winter months. During the summer, close-growing crops in strips cover one-fifth to one-fourth of the cultivated area, and corn and cotton, also in strips, occupy the rest of the cultivated area. In some instances interplanting of corn with summer legumes is substituted for the practice of strip cropping.

Crops used in the soil-saving strips are those needed in a balanced farm program for growing feed—the winter legumes, the small grains, cowpeas, sorghum, and lespedeza. These close-growing crops are seeded on alternate terraces, and the strips extend into the adjoining terrace intervals. About half of the strips that are planted to cotton and corn are seeded to winter legumes after harvest; the others lie idle.

About 8 percent of the formerly cultivated land in the district will be retired to sod, kudzu, and trees. If a field is needed to produce forage, even though it is badly eroded, kudzu is used to reclaim it rather than trees. In this Alabama piedmont country this legume promises to come into

widespread use for reclaiming such fields. Kudzu is established by planting approximately 1,000 crowns or seedling plants an acre in rows 10 to 15 feet apart. The plantings are fertilized and cultivated 1 or 2 years to stimulate growth, control weeds, and provide favorable conditions for the new plants. Some badly eroded fields of gentle slope are temporarily retired to kudzu. The kudzu checks erosion and in a few years greatly improves the soil.

Slopes above 15 percent are generally reseeded to grass or are retired to shrubs and trees (fig. 30). Small areas of abandoned land adjacent to timber stands are reforested. Where scattered trees have appeared on

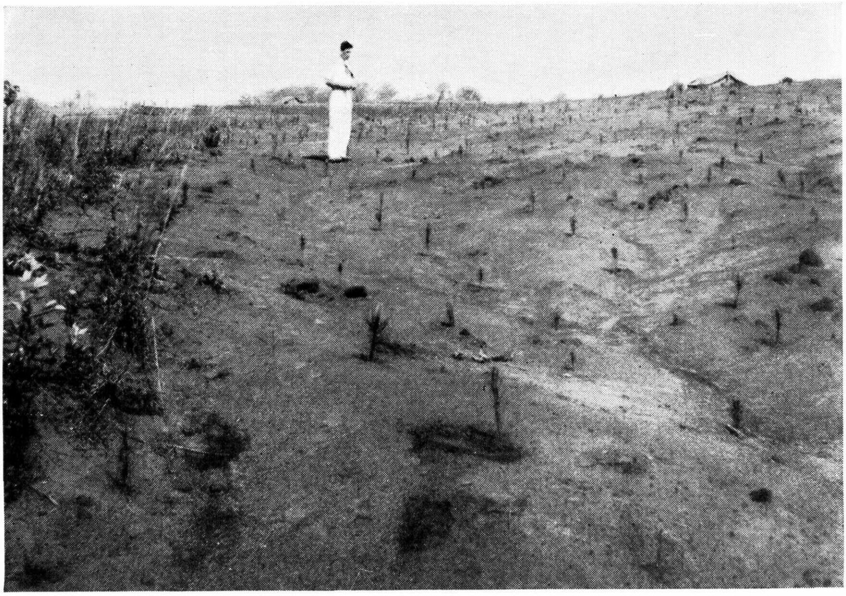

FIGURE 30.—*Slopes too steep for cultivation or too badly eroded to be productive are retired to trees, vines, shrubs, or pasture.*

abandoned land the stand is improved by setting out seedlings of loblolly and on moist flat lands, slash pine.

Full advantage is taken in gully-control plantings of the luxuriance of plant growth in the Alabama piedmont. Simple and inexpensive dams built of brush or rocks, or occasionally of wire and posts, are all that is necessary to hold the soil until the plants become well rooted. Bermuda grass, Dallis grass, and lespedeza are employed in gully plantings in pastures. Kudzu is preferred for gullied lands outside of pasture and forest areas. When planted in soil collected above dams in deep gullies, kudzu makes vigorous growth and is perhaps the most effective plant to use for

control. In areas where many small gullies occur, low brush dams are built and kudzu is planted in the soil that collects above the dam. In gullied areas to be forested, trees and shrubs are set at intervals across gullies. Black locust, Indigobush, and French mulberry seedlings are most frequently used.

Within 2 years after the district had been selected for a demonstration, striking changes were noticeable in the cropping system. In the crop year of 1933 legumes were rarely used for winter cover on these bare Alabama soils. On the average farm of 160 acres, of which about 60 acres were planted to crops, less than 1 acre was seeded to winter legumes. By the winter of 1935 this average 160-acre farm was producing more than 10 acres of winter legumes. The acreage in perennial legumes (kudzu and *Lespedeza sericea*)—hardly measurable in 1933 it was so insignificant—had risen to almost 5 acres a farm by the winter of 1935. Land in small grains rose from slightly over 2 acres to more than 8 acres. In addition, the production of summer hay crops (cowpeas, sorghum, and soybeans) quadrupled in 2 years increasing from less than 2 acres to more than 8 acres a farm. In the winter of 1935 farmers reported having for the first time in their experience enough feedstuffs to carry their stock comfortably through the winter.

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